THE

AGRICULTURAL LEDGER.

1895—No. 1.

ACACIA CATECHU.

CATECHU OR CUTCH, AND KATH.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. I., A. 135–199.*]

Review of the Proceedings of the Government of India (Forest Department) on the subject of the isolation of Catechu *and of* Kath *from the wood of* Acacia Catechu—*by* THE EDITOR.



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The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

E. C. BUCK,

Secretary to the Government of India.

THE

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1895—No. 1.

ACACIA CATECHU.

[*Dictionary of Economic Products, Vol. I.*, A 135—199]

Review of the Proceedings of the Government of India (Forest Department) on the subject of the isolation of Catechu *and of* Kath *from the wood of* Acacia Catechu—*by* THE EDITOR.

The present review is intended to make known recent information

a natural product found within the wood known as *Kirsal*. It was suggested that a more careful examination of these trade products might reveal their independence chemically, and accordingly that the

useful purpose to give here a brief abstract of his original statements and opinions, without which the subsequent particulars might be unintelligible to persons who had not the opportunity of consulting the original.

I.—PREPARATION OF DARK CATECHU, or, as in trade, it is more *correctly designated* CUTCH.

The trees that yield this substance are regarded as mature when about a foot in diameter. They are then felled and cut up into blocks two or three feet long. In some parts of the country the Natives

Trees suited for extraction of Cutch.

bark and the outer sap wood are generally removed and rejected. The red heart-wood is then cut up into small chips. In certain districts the branches are not utilized in the preparation of the extract, in others they are so used.

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Mode of extraction.

The chips are then boiled in water in earthen pots for twelve hours. When the water is reduced by one-half, the chips are taken out and the liquid placed in large iron pans or cauldrons and again boiled and stirred till it attains the consistency of syrup. The cauldrons are then taken off the fire and the stirring of the liquid continued till the mass is cool enough to be handled, when it is taken out and spread on leaves arranged within a wooden frame or mould and left for the night. In the morning the Cutch is dry and then exists as brick-like masses that each weigh 36 to 44lb. These are broken [illegible]

[illegible] ation of the dry extract varies [illegible] the article is made, but the principle is the same as that given above, which may be said to be the Pegu system. Occasionally the chips are boiled a second time with the production of a small amount of inferior stuff. In other cases the red liquid is poured over fresh chips and again boiled.

The stirring or beating process.

From the widespread conviction of the necessity for stirring or beating the concentrated solution (on its being removed from the fire), it might almost be inferred that some chemical change was thereby effected similar to the oxidation produced by beating the indigo-vat solution. Thus, for example, in Baroda the decoction is strained through a blanket. For this purpose the blanket is dipped into the fluid, stirred about and then wrung out, while the blanket is [illegible]

[illegible] through the blanket, the trough is then covered over with a lid of split bamboos and the sediment allowed to subside. The water is then poured off and the extract cut into small cakes and allowed to dry.

In Bariya (Gujrat) the thick decoction is poured into pits, five or six feet deep, in the bottom of which baskets are placed. The liquid drains off, the chips are retained in the baskets, and the solid extract formed on the floor of the pits. This is removed and dried on leaves while exposed to the sun.

Stirring: Conf. with p. 7.

Speaking of the Pegu system, it is admitted that much difference of opinion prevails as to the value and extent necessary of the beating process. One writer says it is more of a "beating up" than stirring, "but I have never been able to ascertain what the object or effect of the process is. Cooks differ, too, in the amount of beating up that is desirable, some being satisfied with half an hour's application." It will be seen below in connection with the subject of *Kath* that a peculiar system of encouraging crystallization (which may be analogous to the beating) is considered essential.

Season for manufacturing Cutch.

In Pegu the manufacture of this article extends from June to March, but the months of December to March are regarded as the best. In April and May scarcity of water is supposed to stop the works, while in the rainy season the difficulty of transport checks the industry.

As to the amount of Cutch yielded by heart-wood, it had been stated that from 3 to 10 per cent. in weight would be a good average. In other words, one ton of timber, in the round, might be taken as yielding 250 to 300lb of Cutch. Yield

The Cutch of trade appears in several forms. The Pegu variety occurs in masses with layers of leaves between the successive preparations. But Cutch is also met with in cubes of various sizes which often Appearance of Cutch.

to dark liver-colour, and in some cases almost black or port-wine coloured. It is inodorous, but has an astringent bitter taste, followed by a sense of sweetness. It is brittle and breaks with a more or less resinous, shining fracture.

II.—Preparation of Pale Catechu or Kath.

removed and the crystalline substance adhering to them is collected and compressed into cubes of various sizes. Whether or not the liquid is rejected or afterwards boiled down to produce a poor quality of dark Catechu or Cutch does not appear to have been ascertained. The crystalline substance *kath*, as met with in the bazars, occurs in irregular pieces, in square blocks or in cubes similar to those of gambier. This is the substance eaten by the Natives of India in *pán* and it is (at least in its purer forms) never exported.

It seems probable, however, that there may exist an industry practised more or less as a secret in various parts of India, in preparing the crystalline article *kath* from the cruder substance Cutch, since its direct preparation from the original decoction has only been observed in Kumaon, though the substance is universally used all over India and fetches a higher price in the bazars than does Pegu Cutch. *Conf. with p. 14.*

gambier having been substituted for catechu in European medicine.

III.—Kírsal or Khersal.

The woodmen when cutting up the trees to prepare the chips employed in boiling for Cutch and *Kath* sometimes come across a substance imbedded in the wood which they carefully remove and sell under the name of *kírsal*. It is much valued by the Hindus and fetches a high price. It has apparently never been chemically examined, but is possibly a pure state of Catechin. Kirsal.

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The Isolation of Cutch.

Chemists, opinion.

The following passages from the Dictionary of Economic Products may be here republished as exhibiting the opinions of some of the leading chemists prior to 1884:—

"Catechu contains a variety of tannic acid called *Mimotannic acid*, [illegible] the bark of Quercus tinctoria, [illegible] *lop Warden.*)

[illegible] upied the attention of chemists for some time back, but as yet the views and conclusions arrived at are [illegible] *ignorance upon these important points may have much to do with the* conflicting chemical results which at present exist regarding the composition of Cutch. There are at least two, if not three, distinct products obtained from each of the Cutch-yielding trees, and it is just probable these may have been experimented upon indiscriminately by the chemists of Europe. It would be but in keeping with other instances of two or more *species (still more so of members of different Natural Orders of plants)*, yielding approximately the same product, to find that the trees which afford [illegible]

Conf. with Warth's analysis, pp. 7, 8.

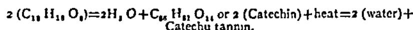
boiling hot water, [illegible] chuic acid on cooling, [illegible] chuic acid, so that [illegible] ether, this substance may be separated for chemical or industrial purposes.

In addition to catechin, Cutch contains, however, other two substances, *viz.*, Mimotannic acid *plus* a gummy extractive principle (=Catechu tannin). Mimotannic acid is soluble in cold water, and by simple maceration may, therefore, be removed from Cutch. The solution will be observed to be of a thick chocolate colour. If heated to the boiling point, it is rendered quite transparent, becoming turbid on cooling. With this

Chemistry of Catechu.

solution ferric chloride gives a dark-green precipitate, which will immediately change into purple on the addition of cold water, or of an alkali.

Catechuic and Mimotannic acids are said to be present in Cutch in about equal proportions. The effect of heat upon Cutch and its compounds is most important, and, as pointed out by Etti, the chemical changes effected by heat afford the most likely explanation of the discordance of authors as to the formula for Catechin. According to Leebermann, confirmed by Etti's re-examination of the substance, the formula for Catechuic acid or Catechin is $C_{15}\ H_{13}\ O_6$. If a piece of Cutch be first heated in a crucible and then macerated it will be found to be completely soluble in cold water. This is explained by Etti as due to the formation of soluble anhydrides from Catechin, thus:



$2\ (C_{18}\ H_{18}\ O_8) = 2H_2\ O + C_{36}\ H_{32}\ O_{14}$ or 2 (Catechin) + heat = 2 (water) + Catechu tannin.

The compound thus produced is known as *Catechu-tannic acid*, and is completely soluble in cold water. By a further loss of water at 190°-200° this becomes $C_{36}\ H_{30}\ O_{13}$. Under the influence of heat the anhydride that is first formed is $C_{36}\ H_{34}\ O_{15}$, an insoluble, brownish-red, amorphous powder, a substance soluble in alcohol and precipitated in crystals ... proportions in a ... nflicting chemical ... *piece of Catechu* ... *should be regarded* ... st probably adulterated by the trader.

For some time Gautier regarded the Catechin of Gambier as quite ...

The soluble Catechu-tannic compounds constitute the active stringent ... for which ... should ...

Solubility: *Conf. with pp. 4, 7, 13.*

Adulteration.

ants. The chief substances ... starch, and dried blood. ... 3 to 4 per cent. It shoul... if soluble in cold water, ... been injured by heat.

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Necessity of Chemical examination urged.

The Dictionary of Economic Products (from which the above abstract has been taken) thus advocated the necessity for a careful chemical examination of the actual samples met with in trade as being likely not only to remove the defective knowledge that has retarded progression and prevented economies in manufacture, but as calculated to reveal the existence of widely different chemical substances in certain forms of the commercial article. It also thus exhibited the injurious action of heat in reducing Catechin and manifested a simple method of separating Catechin from Catechu tannin, owing to the latter being soluble in cold water. It was also assumed that

Separation by heat. *Conf. with pp. 4, 5.*

substances; in other words, of preventing the reduction of Catechin to Catechu tannin, if not of raising the latter to the former state. This much-to-be-desired result has not as yet been attained and there ... But investigations ... to these substances ... would ... und to ... l allow of the residual product (or by-product) being sold at a considerably lower rate than at present without very materially reducing its industrial value and, to thus provide a means whereby the technical industries could use the two articles separately or in fixed combina-

Conf. with p. 5.

as the character of that article.

These, then, were some of the opinions and expectations formed by the Editor when he compiled in 1884 the account of Cutch or Catechu that will be found in the Dictionary. On the Inspector-General of Forests having had his attention directed to the above

The following three reports were submitted to the Government of India through Her Majesty's Secretary of State for India:—

WARTH'S REPORT

Reports on the yield of Catechin from five different qualities of the wood of Acacia Catechu *in Oudh and Burma—by* Dr. H. Warth.

(I.)

12th March 1890.

Wood with white spots

"Early in 1889 an inquiry was started why the professional makers of *kattah* refused 'Khair wood' without white spots, and only worked up those stems which were found to have white spots scattered all through their heart-wood. It was reported that the makers of *kath* cut into the

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[illegible]

Active principle of

"The active principle of cutch is the tannin—that variety of tannin which is called Catechu-tannin, and [illegible] pound with ferric salts. As a rule [illegible] cutch. *Kath,* which is used in [illegible] lime, has catechin for its active pr[illegible] catechin. Catechin and catechu [illegible] resemble each other in some of [illegible]

[illegible] retards the separa- [illegible] extracts of the [illegible] n and catechin, [illegible] to remain in the [illegible]

Experiments with Cutch.

[illegible] e woods named [illegible] the wood specimens. I treated these samples very carefully with acetic ether and with hot water, but I was only able to obtain 6 per cent. of catechin from them, [illegible]

[illegible] with the object of making the extraction complete *A rapid treatment and concentrated solutions are indispensable.* The following method may be followed:—

"About two ounces of finely cut wood are boiled for half an hour with [illegible]

Stirring *Conf with p. 2.*

catechu tannin, it [illegible] begins, and in suc[illegible] *Stirring the liqui[illegible] sometimes effected [illegible] the over-saturated [illegible]* mineral acid has also sometimes the effect of making the catechin separate. [illegible]

The Isolation of Cutch.

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The chief agent in this process of separation is, however, time After enough time has been allowed, the catechin is brought on a filter and ... ried by exposure ... than 40 degrees ... The accounts ... of the product ... was completely dried in warm air, I left it for some time in the desiccator. When I weighed it, it had reached such a state of dryness that it kept increasing slightly in weight on the scale pan through absorption of moisture from the air.

Experiments with Cutch.

"Once the catechin is thus separated and dried, it remains unchanged ... *The pure catechin,* ... *immediately on cooling.* ... catechin and tannin. ... water and then cooled, ... pcial crystals that the

...

much, and, as in some cases only the merest trace of catechin was obtained from the residue, the removal of catechin by the main process appears so far satisfactory.

"I made now with each of the woods a further trial. I treated a por-...

Yield from different woods.

"Oudh No. I.—Reported by the *kath* makers as unfit for making *kath*. One in a thousand of the large pores of the heart-wood filled with white substance.

"Oudh No II.—Reported as good for *kath* About one in six of the large pores filled with white.

"Burma A.—Reported by the Burmese as having no white spots. Has no spots, but cracks filled with white matter (*kirsal*).

"Burma B—Reported by the Burmese as having spots. One in twenty of the pores white.

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"Burma C.—Selected by the Forest Officer as having distinct spots. A very beautiful specimen with large white spots. About one in every three poles white.

Yield from different woods.

"The following table shows the amount of extract obtained at different trials. The extract was of such dryness that it just began to increase a little in weight on exposure to the air:—

Wood.	Per cent. Extract.	Maximum per cent.
Oudh No. I.	6, 9, 10, 14	14
Oudh No. II.	4, 15, 15, 16, 17, 19, 23, 24	24
Burma A	12, 15, 17	17
Burma B	14, 15, 16	16
Burma C	16, 16, 20, 20	20

"The following table shows the amount of catechin separated out of the woods:—

Wood.	Percentage of Catechin in the Extract.	Mean per cent.
Oudh No. I.	33, 38	36
Oudh No. II.	27, 31, 38, 64	40
Burma A	9, 19	14
Burma B	17, 45	31
Burma C	21, 35	28

"From the above we calculate the total yield of catechin in these five woods as follows:—

Oudh No. I.	5	per cent.	catechin	from the wood.
Oudh No. II.	9	"	"	"
Burma A	2	"	"	"
Burma B	5	"	"	"
Burma C	6	"	"	"

Wood with white spots rich in Catechin.

"We have thus ascertained the following facts. *Woods with white spots are richer in extract and richer in catechin* than those without

was bought in the bazar at . consisted of rectangular pieces about 2 inches long. *The pieces are earthy inside, and they have all round their surface a hard crust, one-eighth of an inch thick, rich in tannin.*

"For the determination of catechin, I only took the inner soft portion of the pieces. Even this inner purest portion contained 3 per cent. of wood splinters and sand. The recrystallization yielded the following proportion of catechin—

34, 38, 48 per cent., or, on average, 36 per cent.

"The *kath* which was manufactured for the Oudh Forest Department, and sent to me with the samples of wood of Acacia Catechu early

therefore, *much richer*

ontained also 4 per

of trees should be utilized for the ma.

The inferior trees might be treated se

be centralized, it would be possible

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wood, and to carry on the whole work on a large scale and with improved appliances. *That portion of the extract which would remain over after* ... *could be utilised for making common cutch*

...ttgart, South American woods are ... dyes, *one of them very similar to* ... hot water under ordinary pressure, ...wer temperature in vacuum pans. ...use it prevents much of the dyeing ... imported Burmese cutch is sub... ...nally evaporated in vacuum pans. ...ans would also effect a saving in

Vacuum pans.

---

(2)

CANNSTATT, WÜRTEMBERG, GERMANY;

11th August 1890.

... to report on the amount ...of Acacia Catechu from ...

Yield from different woods.

... 10 to 15 per cent. tannin ... wood for each trial. To test my ... larger quantities—namely, *50lb of* ... *of supposed No. II., which had both* ... *cut the wood on the* ... two or three times ... the fire and finally ... thick, and began ... *rwards stirred it up* ...

...ture.

Preparation of both Kath and Cutch from same wood

"*The liquid which flowed off from the catechin was put to evaporate until it was nearly solid. It was then poured into a paper mould, in which it solidified. Of the produce so obtained I have the honour to submit sam*... the subjoined list.

... the Oudh ... impure ... *kath*) ...

Iron vessels to be avoided.

... artment evidently by a mistake. Instead of ... with a large percentage of catechin, and recognized by white spots, they were a poor kind of wood, in which I could recognize but the merest trace of white spots. When boiling this wood, I also used an iron vessel, which I thought was not dangerous because it had been newly tinned, but the ... insufficient and iron rust got into the liquid. *Iron is such a* ... *whether*

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which I have the honour *to submit samples. According to my former* trials on a small scale, good wood No. II. might have yielded me 9 per cent. of catechin and 15 per cent. of tannin.

"No serio
and it was c
for catechin
although it
species, Acacia Catechu.

Suggestions for improved manufacture.

"I have now the honour to propose an improved method of making catechin and tannin in the North-West Provinces.

the same purpose.

Utilisation of wood with or without spots.

"The smaller yield of catechin from the trees No. I. will be compensated for by the manufacture of tannin for the European market. This catechu tannin will fetch its price there as a catechu of superior, uniform, and always trustworthy quality. From the wood No. II. the improved method will also utilize a large quantity of tannin or pure catechu, which has hitherto been wasted The people pour their mixture of tannin solution and catechin upon sand, when the catechin remains and is dried into cakes, whilst the tannin soaks away into the sand.

Improved filter.

"The catechin itself is also very impure
of *kath*, softening them with c
filter press, I obtained 59 per
of tannin in solution, and 16
wasteful method of filtering through sand, it is proposed to substitute the filter press. The filter press is now universally introduced for separating solid matter from liquids, and it is of special utility in the manufacture of

quite a new start to the process of catechin extraction.

Cutting wood by machinery.

"But the cutting up of the wood by machinery will also afford

"The final desiccation of the tann

poration will be accelerated, and the injury done to the tannin by the boiling will be reduced to a minimum.

"The complete apparatus for the improved process does not cost much Mr. J Gyiketta, an expert for dye and tannin extraction, has given me the following figures:—

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Cost of apparatus for improved manufacture

" A manufactory for extracting 10 tons of wood daily consists of—

	£
2 steam boilers, each of 1,000 square feet heating surface	1,000
Setting up and chimney	250
1 steam engine of about 100 H. P. (or a turbine if there is water power)	600
2 wood cutting machines	200
6 copper vessels for extraction	450
2 copper vacuum pans, each with 500 square feet heating surface	600
1 air pump for the vacuum pans	250
1 filter pump of 100 square feet surface	200
Reservoirs	50
TOTAL	£3,600

" This sum is intended for Europe, and equals about R[illegible] in India [illegible]

[illegible]

year, produce about 3,500 maunds of catechin and 7,500 maunds of tannin dye. The value of the former in India will be at least R1,10,000, considering its great purity, and the value of the latter in India for export to Europe will be about R90,000. The total value of produce per year will be about R2,00,000. The annual produce of the factory will, there-[illegible]

[illegible]

ENCLOSURE.

List of Samples sent on the 9th of August by post viâ Hamburg to the Under-Secretary of State.

Wood of Acacia Catechu, No. I, one piece.
Wood of Acacia Catechu, No. II, one piece.

	Grammes.
Indian kath	125
[illegible]	600
[illegible]	560
[illegible]	[illegible]
[illegible]	770
Tannin from No. II. wood	353
Total weight of kath catechin, tannin	[illegible]

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The whole was reported in the Customs sheet as 3 kilogrammes catechu."

(3)

December 1890.

"In Dr Watt's *Dictionary of the Economic Products of India* we find it [illegible]

Kath and Catechu.

Conf. with p. 6.

purest state [illegible] *nearly insoluble in cold water* [illegible] substance *soluble in cold water* [illegible] is usually mixed up with it. [illegible] s partly due to the [illegible]

Trees of different kinds ? different ages.

[illegible] Provinces, [illegible] although [illegible] the wood, caused by a white substance stored up in cylindrical masses half a millimetre thick and ten millimetres long. Trees No. 1 have no white spots. Trees with spots yield an extract richer in catechin, and both kinds of trees in the North-West Provinces yield more catechin than the corresponding kinds in Burma.

Yield of Catechin.

"I found the following proportions of catechin in the total extract:—

	Catechin.
Burma, No. 1	14 per cent.
" " 2 (spotted)	30 "
North-West Provinces, No. 1	36 "
" " " 2 (spotted)	40 "

"The greatest amount of extract obtained from each kind of wood was as follows:—

Conf. with p. 21.

	Extract.
Burma, No. 1	17 per cent.
" " 2 (spotted)	18 "
North-West Provinces, No. 1	14 "
" " " 2 (spotted)	24 "

"The greatest amount of catechin obtainable from these woods is accordingly as follows:—

	Catechin.
Burma, No. 1	2 per cent.
" " 2 (spotted)	5 "
North-West Provinces, No 1	5 "
" " " 2 (spotted)	9 "

"Such a great proportion of catechin in the spotted wood of the North-West Provinces explains that *kath* manufacture is at home there. Moreover, the local *kath* makers are reported to refuse as unfit all trees which do not contain white spots, so that the trees No. 1 become wasted in the forests.

"I determined the [illegible]

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[illegible] for the [illegible] liquid [illegible] The [illegible] ature,

Separation of Catechin.

[illegible] becau[illegible]

[illegible] ate [illegible] is [illegible] low [illegible] ests [illegible] of [illegible] g is performed in the open air.

Conf. with p. 23.

[illegible] posure to the air, and once dried the catechin is a very durable substance.

"*Contact with iron must be scrupulously avoided during the extraction of catechin.* With catechu or cutch contact with iron is of no consequence, and the reports mention iron caldrons in use for the final boiling down of the cutch in Burma.

Preparation of Cutch.

[illegible] than that of [illegible] required and [illegible] the surface [illegible] to effect the [illegible] med, but not [illegible] extraction. In [illegible] the use of [illegible]."

The passages in the above which the Editor has ventured to render in italics seem worthy of special consideration as likely to have a direct bearing on any future expansion and improvement in the production of *Kath* and Cutch. Dr. Warth's observation that wood spotted with white deposits is richest in Catechin and that such [illegible] pointed out by Ettl), Dr. Warth was enabled to separate these two substances. The concentrated decoction was by him simply set aside for five days, to allow of the formation of the crystalline Catechin. Cold water was then added and the solution filtered. By this simple contrivance Catechin was separated and the filtrate

subsequently boiled down to form Cutch. It is possible that it may be by some such process that some of the *Kath* sold in India is prepared from the crude Cutch, since it is hardly admissible that the whole of the *Kath* consumed can be derived from the comparatively limited production in Kumaon. If this supposition be not correct it might be possible to organise a fairly remunerative industry in refining *Kath* from Cutch. But it may be pointed out that Dr. Warth has not touched on the further question as to the possibility, by chemical or mechanical contrivances, of increasing the yield of Catechin, or at all events preventing its degeneration—points briefly indicated in the above review of the chemistry of the subject (p. 5).

Preparation of *Kath* from Cutch.

Conf. with p. 25.

The correspondence that ensued on the publication of Dr. Warth's proposal to found a central factory for the purpose of manufacturing *Kath* and Cutch is too extensive to be here given in full. It may, however, be stated that it was brought out that except in Burma and the Central Circle of the North-West Provinces, no forests of this tree exist which, within workable limits, could [illegible] ing opinions were advanced.

Establishment of Kath factory.

In Upper Burma some extensive cutch forests exist in the Yaw and other side valleys of the Chindwin. These have not, however, as yet been sufficiently explored, and those in the Pyinmana district are already severely worked. The recommendation was strongly opposed to create a Government *Kath* factory in competition with a well-developed manufacture and trade of considerable magnitude, in which some of the leading European firms of Burma are largely interested. It was held that the competition in the article in question was already very keen, and that it may be taken for granted that improvements in manufacture will be readily accepted by those interested without Government taking any further action than to institute investigations.

Supply in Burma.

[illegible] or widens with the general formation of the country, and, following the banks of rivers, frequently extends far into the Terai. The forest has no doubt always been mutilated and frequently destroyed by incessant firing; but even in the latter case dead stumps and other traces of the original forests can be found almost invariably; and where the forests have been protected, they have rapidly regained possession of the soil and produced a crop of considerable density. The area of Government forests in the Kumaon district, which is still in occupation of the *khair* tree, is estimated by the Conservator of Forests to aggregate 50,000 acres. The Acacia Catechu is by no means a small tree by nature, but is often dwarfed by continuous maltreatment.

Supply in N.-W. Provinces.

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The Isolation of Catechu.

Further experiments.

In the correspondence alluded to the very important remark was made "that results are frequently obtained in a laboratory which cannot be realized when dealing with large quantities." It was consequently proposed that further experiments be made with Dr. Warth's process on a somewhat extended scale. It was suggested that these experi- [illegible] present such machinery need not be procured. But in Burma where such experiments were made some time ago, it was found the saving in chopping the wood by machinery was more than absorbed by the transport of the logs in bulk. It was regarded as desirable at least for the present to leave the use of vacuum pans out of consideration, and the only plant which it was thought necessary for the experiments were some copper vessels and a filter-press.

[illegible] A., June 9th, 1891), wrote:—

Assam opinion about Central Factory.

"Dr. Warth's figures relating to the outturn of catechin and cutch [illegible] which the proportion of extract yielded is only about one-sixteenth, or 6 per cent. of the wood used. It has also been suggested by a Calcutta [illegible] extract the catechin.

[illegible] penses of three cutch boilers brought over from Burma and on the purchase of stores, erection of sheds, etc. But when such items are deducted from the total cost, there still remains a balance of R1,716 to be debited against the experiments on account of labour alone, or more than three times the return realised from the produce sold. This last season five maunds were specially made for the Economic Reporter for R100, or R20 per maund, which shows a great reduction on the cost of the former year, but which is still nearly double the selling price of the article. So far, therefore, we cannot be said to have proved that cutch-boiling can be carried on in the Assam forests with much chance of success.

Failure in Assam

Proposed working of Assam forests.

"It may also be noticed that a Calcutta firm has offered to work our *Khair* forests on the following conditions:—

(1)

(2)

(3)

R1 per tree, provided mature trees are available.

"I should be inclined to recommend the latter method of working the forests to attempting any further experiments departmentally; but would fix the royalty at R2 per mature tree of 4 feet girth. Before, however, inviting private enterprise to step in and work for us, I think we should await Dr. Warth's opinion on the resources at our disposal mentioned in this report."

Resources of Assam forests.

The resources to which the Conservator of Forests in Assam alludes are as follows:—

Area of Khair Forests in Assam.

Goalpara	9,000	acres.
Kamrup	5,000	"
Darrang	4,480	"
	18,480	acres.

At present capable of yielding per annum:—

Goalpara	trees of 4 feet and over	2,000
Darrang	trees of 3 feet and over	1,600

And allowing a margin for the timber of the above damaged by fire and not available for cutch-making, it may be roughly estimated that the yearly outturn of raw material obtainable from the above would equal about 46,000 cubic feet or 23,000 maunds.

Burma opinion on Warth's suggestions.

The Conservator of Forests, Pegu Circle, Burma (in letter No. 809, dated 13th October 1892), reported that—

this be the case, to extract the Catechin would be to greatly lower the

Conf. sei pp. 16, 19.

Samples of Cutch were procured from Burma and submitted to the Assistant Agricultural Chemist to the Government of India, who furnished the following report:—

ACACIA Catechu.

The Isolation of Catechu,

Further experiments.

In the correspondence alluded to the very important remark was made "that results are frequently obtained in a laboratory which cannot be realized when dealing with large quantities." It was consequently [illegible]

such experiments were made some time ago, it was found the saving in chopping the wood by machinery was more than absorbed by the transport of the logs in bulk. It was regarded as desirable at least for the present to leave the use of vacuum pans out of consideration, and the only plant which it was thought necessary for the experiments were some copper vessels and a filter-press.

From the correspondence that ensued regarding the proposal to *form a central factory the following extracts may be given, since these* appear to either amplify the published information or raise points for future enquiry. The Conservator of Forests, Assam (letter No. 63 A., June 9th, 1892), wrote:—

Assam opinion about Central Factory.

"Dr. Warth's figures relating to the outturn of catechin and cutch obtained from both inferior and good woods, show that he procured from 14 to 24 per cent. of extract from the raw material, a far larger proportion than is obtained by the rough working process in vogue at present, by which the proportion of extract yielded is only about one-sixteenth, or 6 per cent. of the wood used. It has also been suggested by a Calcutta firm having large dealings in Burma cutch that this produce as manufactured by the vacuum pan process, being quite free of catechin, would be much less valuable for dye purposes than the cutch prepared in the rougher manner, as in Burma and elsewhere, by which a large proportion of the catechin is retained in the cutch; and it is certainly strange that, in the North-West Provinces, where catechin alone is made, the cutch residue is considered of no account and not worth preserving; while in Burma, *where I believe cutch only is prepared, no attempt is made to* extract the catechin.

"[illegible]

Failure in Assam

penses of three [illegible]
chase of stores, [illegible]
from the total [illegible]
against the exp[illegible]
times the return realised from the produce sold. This last season five maunds were specially made for the Economic Reporter for R100, or R20 per maund, which shows a great reduction on the cost of the former year, *but which is still nearly double the selling price of the article. So far,* therefore, we cannot be said to have proved that cutch-boiling can be carried on in the Assam forests with much chance of success.

Proposed working of Assam forests.

"It may also be noticed that a Calcutta firm has offered to work our *Khair* forests on the following conditions:—

(1) [illegible]

(2) [illegible] heir exclusive

(3) [illegible] (2) a first [illegible]

[illegible]

Resources of Assam forests.

The resources to which the Conservator of Forests in Assam alludes are as follows:—

Area of Khair Forests in Assam.

Goalpara	9,000	acres
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Darrang	4,480	,,
	18,480	acres.

At present capable of yielding per annum:—

Goalpara	trees of 4 feet and over	2,000
Darrang	trees of 3 feet and over	1,600

[illegible]

Burma opinion on Warth's suggestions.

"[illegible]

this be the case, to extract the Catechin would be to greatly lower the [illegible]

Conf. with pp. 16, 19.

[illegible]

Samples of Cutch were procured from Burma and submitted to the Assistant Agricultural Chemist to the Government of India, who furnished the following report:—

ACACIA Catechu.

The Isolation of Cutch,

Analysis of Burma Cutch.

RESULT OF CUTCH ANALYSIS—*Burma Samples.*

	(a) Tablets (W. C.) from Sinbyukyun, Rangoon price R60 viss.	(b) Tablets (W. C.) from Myingyan, Rangoon price R80 viss.	(c) Tablets (W. C.) from Sallamys, Rangoon price R58 viss.	(d) Block (W. C.) from Tabekin, Rangoon price R57 viss.	(e) Block (W. C.) from Pakôkku, Rangoon price R57 viss.	(f) Block (P. C.) from Thayetmyo, Rangoon price R57 viss.	(g) Block (P. C.) from Paungdé, Rangoon price R57 viss.	(h) Block (E. C.) from Mandalay, Rangoon price R57 viss.	(i) Soft (E. C.) from Mandalay, Rangoon price R45 viss.	(j) Soft (P. C.) from Paungdé, Rangoon price R45 viss.	(k) Soft (P. C.) from Thayetmyo, Rangoon price R45 viss.	(l) Soft (P. C) from Prome, Rangoon price R45 viss.	(n) [illegible] Rangoon price R45 viss.	(o) Block (E. C.) from Pyinmana, Rangoon price R55 viss.	(p) Block (E. C.) from Kambalu, Rangoon price R57 viss.
Moisture	17·3	22·7	12·0	29·9	18·2	27·1	16·3	17·4	41·9	27·2	27·3	31·3	33·8	36·5	37·0
Catechin	11·1	15·8	13·6	12·5	12·7	19·0	11·3	13·0	10·5	9·7	12·2	13·7	9·2	10·3	11·8
Tannin	68·8	61·3	73·9	56·1	68 8	53·5	72·1	68·2	46·4	60·5	59·5	54·4	56·1	51·1	51·0
	97·2	99·8	99·5	98·5	99·7	99·6	99·7	98·6	98·8	97 4	99·0	99·4	99·1	97·9	99 8

NOTE—
E. C. for Eastern Circle.
W. C. for Western Circle.
P. C. for Pegu Circle.

Analysis of Burma Cutch.

These analyses manifest an extraordinary range in composition of ordinary Pegu Cutch. In sample (*c*) there was 12·0 moisture (—a tablet of Cutch valued at R58 per viss), while in (*i*) there was 41·9 [illegible] ange of Catechin was [illegible] Catechin (soft Cutch [illegible] l at R57). It would also appear that in amount of Catechin found in the produce the three Forest Circles of Burma are very similar, thus the three highest were (*f*) from Pegu, (*b*) from the Western, and (*m*) from the Eastern Circle.

Turning now to the proportion of Catechu tannin the extremes were sample (*c*) 73·9 (a tablet valued at R58) and (*i*) 46·4 (soft Cutch valued at R45), also (*p*) 51·0 (a block Cutch valued at R57). There was thus remarkably little difference between the price paid for the sample with the highest amount of Catechu tannin and those with the lowest proportion of that substance. In what, then, lies the superiority? Sample (*b*) that fetched the highest price in the series has considerably more moisture than either (*a*) or (*c*) and it has less Catechu tannin but more Catechin than either of these. But sample (*f*) has considerably more Catechin than (*b*), though it fetched R23 per viss less, and (*m*) has the same amount of Catechin as (*b*), though it fetched little more than half the price. Sample (*k*) fetched the same price as sample (*n*), though it was found to contain 3 per cent. more Catechin and 3 per cent. more Catechu tannin.

The highest priced sample (*b*), valued at R80 per viss, manifests chemically nothing to justify its valuation. It is thus significant that the chemical analysis of an article which owes its merit to the presence of certain definite compounds should thus be at complete variance with commercial valuation. This result would thus appear to throw some doubt on the opinion advanced by the Conservator of Forests, Pegu, *viz.*, that the removal of Catechin would considerably lower the value of crude Cutch. This may be so, but the reason why has not as yet been demonstrated. It is true that the highest prices recorded above are for samples with a high yield of both Catechin and Catechu tannin, but even in this respect the valuations are not consistent :—

Conf. with pp. 16, 17.

	(*b*) R80.	(*a*) R60.	(*c*) R58.	(*f*) R57.	(*h*) R57.	(*k*) R45.
Catechin . . .	15·8	11·1	13·6	19·0	13·0	12·2
Catechu tannin . .	61·3	68·8	73·9	53·5	68·2	59·5
	77·1	79·9	87·5	72·5	81·2	71·7

The highest priced [illegible]

ACACIA Catechu.	The Isolation of Catechu.

N.-W. Provinces: Opinion on Warth's report.

Mr. J. S. Gamble, *Director of the Imperial Forest School*, in a communication (No. 53, dated 3rd August 1893) furnished an instructive statement of the investigations up to that date. The following paragraphs may here be given of Mr. Gamble's contribution :—

I have the honour to reply to your No. 504 of 14th June 1893 I think it best to go over the whole subject in order to make matters somewhat clearer than they are, for I confess to have been a little puzzled about

[illegible]

came ten more copies of these reports, and the request that I should arrange to *continue the experiments at the Forest School, and also report* my views on the subject especially as regards the details of the arrangements to be made and the plant necessary. Your letter was sent for [illegible] the School Circle I [illegible] information as to [illegible] o teaches Natural Science then submitted to me the following note :—

"We have considered this subject together and the following are our views thereon.

"Dr. Warth appears to have made conclusive experiments regarding the amount and quality of extract to be obtained from the different kinds of wood mentioned in his [illegible] the e[illegible] posed [illegible] by Dr [illegible] over [illegible]

[illegible] their small size.

[illegible] Division in his letter No. 412.

[illegible]

Dún wood, and I beg to submit copy of his report No. 13 of 27th January 1893.* — N.-W. Provinces: Opinion on Warth's report.

5. I now turn to the Assam correspondence. In his letter No. K. 92 of 6th July 1892 the Conservator of Forests, Assam, wrote as follows:—

"In a report lately submitted to the Government of India on the possibilities of working the Assam *Khair* forests on the lines indicated in ... India, *Revenue and* ... ed 17th June 1891, ... in the proportion ... ment, on the rough Burma plan, and that obtained by Dr. Warth in his laboratory experiments. Naturally *our experiment showed a much less yield, the figures* being 6 per cent. of extract as compared with Dr. Warth's varying proportion of from 14 to 24 per cent † I proposed therefore that several samples of our *Khair* wood should be sent to Dehra for analysis, and I now have the honour to enquire if you would kindly undertake the experiment. In the meantime I have ordered 15 sample sections of 2 cubic feet each, to be prepared with the bark on, which will be despatched as soon as practicable, after I receive your reply. Please be good enough to state if samples half the above size would be large enough."

* See above, p. 18.

† See above, p. 13.

In reply I wrote: "Dr. Warth is no longer in Dehra, and it is rather doubtful if there is any body at present capable of conducting experiments in the way he did, we will, however, see if we can manage it, and I would suggest your sending only a few samples of one cubic foot each at first." None have, however, yet come to hand, so that I have been unable to furnish the report called for in your No 804 of 27th September 1892.

6. Then came the Burma correspondence. Your *endorsement No.* 935 of 5th November 1892 communicated to me the request made by you to the Conservator of the Pegu Circle to send some samples (say, 25lb each) of Burma Cutch of different market values to this institution to be analysed by the Agricultural Chemist in order to ascertain the quantity of Catechin which each sample may contain In February 1893 the specimens of cutch duly arrived, the boxes being marked A. to P. ‡

The specimens were handed over to Mr Collins, Assistant Agricultural Chemist, in the absence of the Agricultural Chemist, and Mr. Collins was at work on them when he was ordered off to Poona. Dr. Leather informs me that his enquiries are not yet completed and cannot be completed until Mr Collins returns.

‡ *For report see above, page 18.*

Report by the Agricultural Chemist.

The enquiry into this subject was then undertaken by Dr. Leather, Agricultural Chemist to the Government of India, who furnished two valuable contributions that may now be given—

...

might be most readily separated.

2. *In principle I have adopted the same method* as that used both ...

ACACIA Catechu.

Report by the Agricultural Chemist.

The Isolation of Catechu,

TABLE II.

	Ratio. Wood. : Water.	Crude Catechu-tannin.	Crude Catechin.	Total Extract.
Saw-dust	1 : 20 (Canal-water.)	8·1	4·9	13·0
	1 : 20 (distilled water.)	7·4	6·2	13·6
Chips	1 : 5 (Canal-water.)	3·05	1·75	4·8
	1 : 5 (distilled water)	2·04	1·75	3·79

The three conclusions arrived at by Dr. Leather are likely to be regarded as of considerably more practical value than the results obtained by Dr. Warth, since State factories are not likely to be undertaken. The labour employed by the native manufacturer is, however, scarcely likely to be easily taught the superior merits of the plane for many a long day. But the advantage of less water and consequently less boiling are two points that it might be possible to induce him to accept. By doing so there would not only be an economy of time and money, but, as shown by Etti, a saving in the amount of Catechin, since by continued heat a decomposition of that valuable ingredient must take place. The injury pointed out by Dr. Warth caused through the use of iron cauldrons is one that Government might become the pioneers in reforming by procuring copper cauldrons and hiring these out at a low price until the people had appreciated their value. This state of affairs is not unknown to the people of India. The distillers of *rusa*-oil, for example, regularly hire copper stills from the money-lenders and rarely possess their own apparatus.

The following further analyses have been furnished by Dr. Leather, Agricultural Chemist to the Government of India, (February 2nd, 1895) of six samples of North-West Himálayan (Dehra Dún) Acacia Catechu wood. "The figures in the statement below express parts per 100 parts of wood":—

Analysis of Dehra Dún Catechu Wood.

	I	II	III	IV	V	VI
	Shavings.	Shavings.	Shavings.	Shavings.	Shavings.	Shavings.
Catechin	0·42	0·37	3·07	3·61	2·5	3·36
Catechu-tannin	2·72	2·01	7·5	5·44	8·11	5·29
			Chips.	Chips.		
Catechin	—	—	1·91	2·53	—	—
Catechu-tannin	—	—	5·55	4·17	—	—

amounts of Catechin and Catechu-tannin determined in them The

'shavings'.

Causes of variation in yield.

The very remarkable range in yield, between No. I and No. IV, in Catechin and between No I and No. V in Catechu-tannin, makes it extremely desirable that in all future analyses it should be definitely ascertained what are the peculiarities of each sample about to be examined. It is impossible to suppose that so great a difference could be

been told that No. I was a portion of wood taken from the outer zones of the heart-wood and No. IV from the more central, we would have been justified in definitely affirming that the latter zone was richer in Catechin than the former; in other words, that Catechin was a subse-

certainly

fest the

with the

t a high

yield of Catechin is associated with a comparatively small amount of Catechu-tannin. These observations, imperfect and unsatisfactory though they are,

have hitherto made

and that to accom

more careful consideration. It is necessary not only to work out the chemical changes that take place in the various systems of manufacture (pursued by the people of India), but to clearly ascertain the various changes that occur within the tissues of the plant before the deposition of Catechin takes place. A definite knowledge of these

and method of

y to our being

at all attain-

CONCLUDING REMARKS.

Concluding remarks Conf. with p. 14.

In the subsequent correspondence that ensued on this subject, the author of this review suggested that the secret which the Kumaon workers are said to husband so carefully, might be in the direction

ACACIA Catechu.

The Isolation of Cutch.

Secret of Kumaon *kath* makers.

of converting a large proportion of the Catechu-tannin into Catechin. That suggestion was, however, purposely guarded as a mere speculation and one founded mainly on the observation that within the tissue of the plant this appears to be the order of formation. The

supposed to contain, the soluble Catechu-tannin, when its retention would so materially increase the bulk of the article they manufacture, or might be sold separately. It was pointed out at the same time that there should be no difficulty in putting these surmises to practical test. For example, a quantity of the sand which the Kumaon manufacturers use as their filter should be found rich in Catechu-tannin if it be the case that they remove only the crystalline Catechin, in the manufacture of *kath*, and reject the Catechu-tannin as useless. The

tannin material. If higher than the chemical results we should be justified in believing that they actually do convert some portion of the Catechu-tannin into Catechin. So in a like manner the price at which Kumaon *kath* is sold, as compared with Pegu Cutch, should give some indication, since the former, if it consists of only the proportion of Catechin found by the Chemist in the wood, should be considerably more than twice the value of the Pegu article.

These suggestions led to some further communications, though up to date it cannot be said that all the difficulties with which the cutch and *kath* industries are involved have been satisfactorily solved. The

wood used has, how-

pear to be conflicting.

North-West Provinces,

Experiments in N. W. Provinces.

"The experiments made in this Circle show that a cubic foot of wood

cubic feet of wood are required; this quantity of wood includes sapwood estimated to be 25 per cent of the whole quantity."

"It has also been ascertained that the same quantity (82lb) of Cutch is produced from 917 lb of wood (heart-wood only)."

It will be observed that it is not expressly stated, regarding the [illegible] Improve-

great [illegible]

Th[illegible] has be[illegible] whethe[illegible] mechanical or other injuries to the growth of the plant. The replies received would repudiate this suggestion on the ground—

"that it appears to b[illegible] the trees by wounding [illegible] wood"—*Dr. Leather* [illegible] dated 30th September [illegible] dation and chiefly fron [illegible] [illegible]rds [illegible] to [illegible]

But it may be pointed out the removal of gum or any other mechanical disturbance to the life of the plant through wounds, diseases, drought, etc, might easily enough cause a deposition of the crystalline matter within the wood. The irritation caused by sand within the oyster *shell is believed to be the exciting cause to the formation of the pearl.* Barus camphor is deposited within the wood of **Dryobalanops Camphora** very much after the same manner as catechin (*Khsal*) within that [illegible]

found to contain deposits of camphor freely, so that the tapping process has come to be regarded as facilitating the formation of the much-prized article. The formation *Agar* (a crystalline substance found within the wood of **Aquilaria Agallocha**) is believed to be due to some diseased condition. The formation of the crystalline substance [illegible]

tabáshir. (*Dict. Vol. I, 385*). It is not unusual in fact in agricultural operations to check the growth of plants so as to cause the *formation of reserve materials. In the production of ganja it is* found necessary to remove the male plants since the fertilization of the female destroys the formation of the narcotic. But in some

ACACIA Catechu.

The Isolation of Catechu and of Kath.

Points for investigation.

parts of the country (as in Burma) this same result is obtained by injuring the stems. Without mentioning other such examples it may *fairly well be said that it remains to be demonstrated that the yield* of Catechin is not a matter that is capable of control. It was, however, from analogy in similar instances that the writer ventured to make the suggestion that the formation of Catechin might be facilitated by mechanical agencies or other disturbances to the life of the plant. This, however, was only a suggestion, though it is one that might still be kept in view. The most important points that remain to
that take plac
of Catechin);
means of cau
of the plant or during the process of manufacture; (*c*) to ascertain the age of the trees at which that substance is most freely formed and, if expedient, to frame a system of forest conservancy based upon the knowledge thus obtained; (*d*) to establish the nature of the environment most favourable to its production, and hence to draw up a map of India that would show the distribution of **Acacia Catechu** and the tracts within that area where Catechin might be manufactured and those in which the cruder article only could be produced; (*e*) to determine the nature and yield of the Catechu compounds obtained from the other species of **Acacia** that are reputed to afford these substances; (*f*) to elaborate a more exact and scientific method of manufacture than that which prevails, and one which could be adopted by the *Khair* workers; (*g*) to have a series of comparative experiments performed in both Burma and Kumaon, to ascertain whether the Native methods pursued in these centres of

IN CAMP ASSAM:
March 25th, 1895.

GEORGE WATT.

A. 135—199.

G. I. C. P. O.—No. 2 R. & A.—9-7-95.—2,000.—De'S.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

(Vegetable Product Series, No. 89.)

THE AGRICULTURAL LEDGER.

1905—No. 1.

SCHLEICHERA TRIJUGA.

(KUSUM TREE OF INDIA.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. VI., S. 950-958.*]

Paka seeds as the source of Macassar oil.

By DAVID HOOPER, F.I.C., F.C.S.,



CALCUTTA
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.

The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in the Ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

To facilitate the preparation of an index to THE AGRICULTURAL LEDGER the following arrangements have been made, commencing with 1900:—

All papers published will be paged, irrespective of subjects, into an annual volume.

The annual paging will be given on the top of the pages. But to permit of a continuation of the classification into the various series hitherto observed, a further folio will be shown at the bottom of the pages. This will be preserved throughout each series and be continued for several years, until in fact sufficient material in each series has been accumulated to constitute a fair sized volume.

At the end of the year a printed index and title page will be issued, for the annual volume, and after a period of, say, five years an index and title page will be issued for each series. It has been found that many persons subscribe for a certain series of papers only and do not care to receive the others. The new arrangement, while permitting of the formation of an annual volume, will at the same time retain the serial classification.

THE

AGRICULTURAL LEDGER.

1905—No. 1.

(Vegetable Product Series, No. 89.)

THE

AGRICULTURAL LEDGER.

1905—No. 1.

SCHLEICHERA TRIJUGA.

KUSUM TREE OF INDIA.

[*Dictionary of Economic Products, Vol. VI.*, S 950-958.]

Paka seeds as the source of Macassar oil.

By DAVID HOOPER, F. I. C., F. C. S.

At the instigation of Mr. I. H. Burkill, Officiating Reporter on Economic Products to the Government of India, an enquiry was made in 1903 into the distribution and possible trade in the products of the *kusum* tree. It had recently been discovered that there was an extensive demand from abroad for the seeds, and the Forest Department was asked to take the opportunity to ascertain from local sources the actual uses and value of the tree. INTRODUCTION.

The Inspector-General of Forests accordingly addressed the following letter to all Conservators :— Enquiry by Forest Department.

"My attention having been drawn to the possibility of a trade being established in the seeds of the tree known as Schleichera trijuga which is believed to be the original source of Macassar oil, I have the honour to request that you will be good enough to favour me with a report on the following points :—

1. Is Schleichera trijuga found in your circle?
2. Is any use made of the seeds at present?
3. Supposing a demand were to arise for the seed, what amount would be available, and at what approximate cost?
4. In districts where the lac insect is extensively found upon Schleichera trijuga, is a trade in both products—seed and lac—compatible.
5. To what extent does the habit of lopping off branches to feed cattle interfere with the fruiting of the tree?"

AGENTS.

In Britain.

Mr. E. Arnold, 41 & 43, Maddox Street,

[illegible]

Mr. Bernard Quaritch, 15, Piccadilly, London.

Mr. B. H. Blackwell, 50 & 51, Broad Street, Oxford.

Messrs. Deighton Bell & Co., Cambridge.

Messrs. Henry S. King & Co., 65, Cornhill, and 9, Pall Mall, London.

On the Continent.

Messrs. R. Friedländer & Sohn, Berlin, N. W. Carlstrasse, II.

Mr. Otto Harrassowitz, Leipzig.

Mr. Karl W. Hiersemann, Leipzig.

Mr. Ernest Leroux, 28, Rue Bonaparte, Paris.

Mr. Martinus Nijhoff, Hague, Holland.

In India.

Messrs.

Thacker, Spink & Co., Calcutta and Simla.

Newman & Co., Calcutta.

R. Cambray & Co., Calcutta.

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Superintendent, American Baptist Mission Press, Rangoon.

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(Vegetable Product Series, No. 89.)

THE

AGRICULTURAL LEDGER.

1905—No. 1.

SCHLEICHERA TRIJUGA.

KUSUM TREE OF INDIA.

[*Dictionary of Economic Products, Vol. VI.*, S. 950-958.]

Paka seeds as the source of Macassar oil.

By DAVID HOOPER, F. I. C., F. C. S.

INTRODUCTION.

At the instigation of Mr. I. H. Burkill, Officiating Reporter on Economic Products to the Government of India, an enquiry was made in 1903 into the distribution and possible trade in the products of the *kusum* tree. It had recently been discovered that there was an extensive demand from abroad for the seeds, and the Forest Department was asked to take the opportunity to ascertain from local sources the actual uses and value of the tree.

Enquiry by Forest Department.

The Inspector-General of Forests accordingly addressed the following letter to all Conservators :—

"My attention having been drawn to the possibility of a trade being established in the seeds of the tree known as Schleichera trijuga which is believed to be the original source of Macassar oil, I have the honour to request that you will be good enough to favour me with a report on the following points :—

1. Is Schleichera trijuga found in your circle?
2. Is any use made of the seeds at present?
3. Supposing a demand were to arise for the seed, what amount would be available, and at what approximate cost?
4. In districts where the lac insect is extensively found upon Schleichera trijuga, is a trade in both products—seed and lac—compatible.
5. To what extent does the habit of lopping off branches to feed cattle interfere with the fruiting of the tree?"

The replies of the Forest Officers were of great value, and the Inspector-General having courteously placed them at the disposal of the Reporter, they have been embodied with other material in the present Agricultural Ledger.

Schleichera trijuga, *Willd.; Fl. Br. Ind. 1., 681.*, SAPINDACEÆ.

THE LAC TREE OR KOSUMBA; THE CEYLON OAK.

Vernacular.

Vern.—*Kosum, kusum, gausam,* HIND.; *Puvatti,* KADERS.; *Baru,* SANTALI; KOL.; *Kosum, kohan, koshimb, peduman,* MAR.; *Kosum, kocham, kosumb, gosam, assumar,* GUJ.; *Komur, pusku,* GOND.; *Rusam,* URIYA; *Kussam, kojba,* C. P.; *Samma, jamoa, gausam, kussumb,* PB.; *Pava, pu, pulachi, zolim buriki, pumarum, pularari, puva,* TAM.; *Pusku, posuku, pusi, may, mayi, rotanga, roatanga,* TEL.; *Sagdi, 'sagade, akota, chakota,* KAN.; *Chendala,* COORG; *Puva,* MAL.; *Gyo, kyetmouk, kobin,* BURM.; *Kon, kong, conghas,* CING.

Kusum is the Hindustani name for the Safflower plant, and perhaps refers to the colouring matter of the lac-insect which often feeds upon the tree. The seeds are called *paka* or *pacca* in Calcutta.

Habitat.

Habitat.—"Dry, chiefly deciduous forests in the greater part of India, Burma, and Ceylon, but apparently absent from Bengal and Assam. It is found from the Sutlej to Nepal in the lower Himalaya, Sub-Himalayan tract and Siwalicks up to 3,000 feet, throughout Central India, the East and West coast regions, the Deccan and Carnatic, in all deciduous forests throughout Burma and in the low country of Ceylon up to 2,000 feet." (**Gamble,** *Manual of Indian Timbers*, 2nd ed. 195.) The tree is not wild about Calcutta, but seeds abundantly in cultivation, and the seeds falling to the ground come up freely. The tree may therefore be said to be found over the greater part of India, excluding the following localities: Ajmer-Merwara, Baluchistan, Sind, North-West Frontier Province, Assam, and the Andaman Islands.

The circular note sent to Forest Officers by the Inspector-General in 1903 has resulted in fixing somewhat more definitely the actual distribution of the tree throughout India.

Bengal.

Bengal.—The tree occurs in Santal Parganahs, Palamou, Singbhum, Angul and Puri divisions. Samples of oil in the Indian Museum were received from Palamou and Angul divisions.

United Provinces.

United Provinces.—It is uncommon in the Oudh Circle, but common in the hilly *sál* forests of the Gurwhal division, and in the hills of the Ganges division from the Ganges to the Ramganga river.

Its occurrence is also reported from the School Circle including Dehra Dun, but throughout the provinces it only grows sporadically and is not generally found in groups. Habitat.

Central Provinces.—It is found in all the hill forests of the Berar Circle, and in all the districts of the Southern Circle, but it cannot be said to be plentiful except in the Raipur district, and fairly plentiful in the Bilaspur district. Central Provinces.

Panjab.—**Schleichera trijuga** occurs only in the Kalesar range, Simla division, and there only in small quantities. Panjab.

Bombay.—The tree is found in the Northern Circle, widely scattered, though not in abundance, throughout the Thana district, Surat and the Dangs, and in small quantities in the Panch Mahals. In *the Central Circle it occurs at Khandesh and along the Ghat line of* Nasik, Poona, and Satara. *In the Southern Circle it is fairly common* in the Kanara forests, and to a small extent in the Kolaba district. Bombay.

The tree is found all over Coorg.

Madras.—Reports show that it is fairly abundant in Ganjam. It is fairly abundant in the Rampa territory in Godaveri, but sparingly in the reserved forests; the species is also found in the Agency tracts, including Bhadrachellam sub-division. In Coimbatore it is scattered through the country, more commonly on the banks of rivers. It is widely distributed in the Nudumalai range and along the *margin of streams in the Seegar range in the Nilgiris. In North* Malabar it is found in *fairly* large *quantities* in the Begur and Chedlik ranges, and South Malabar in the Palghat range. Anantipur and South Canara produce it to a trifling extent. It is found in small numbers in Ghat forests in the Nangemeri, Ambasamudran, *and Courtallam ranges in Tinnevelly. There are only one or two* localities in the Central Circle, Madras, where the tree grows, and it never attains a great size. Madras.

Travancore.—The tree occurs at the foot of the hills and on their *lower slopes. It is extensively* planted along road sides, but nowhere occurs in great abundance in a wild state. Travancore.

Burma.—With the exception of South Tenasserim, **Schleichera trijuga** is fairly plentiful in all the divisions of the Tenasserim Circle, and it is fairly common in Pegu. From Upper Burma the *Conservator reports a fairly plentiful* occurrence in the Chindwin Valley, but a scarcity elsewhere in the Northern Circle. It is fairly common in many of the forests of the Southern Circle, particularly in the Madaya and Ruby Mines forests and Shan States. Burma.

The tree is distributed to Java and Timor.

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SCHLEICHERA trijuga. Paka seeds as the source of

Macassar Oil.

Macassar oil.

A preparation for the hair has been known since the early Victorian era, as Macassar Oil, against which the common and old-fashioned Anti-macassar was originally intended to protect couches and chairs, but its origin has for many years been carefully guarded as a secret. The name Macassar was probably derived form the fact that the seeds yielding the oil came originally from the Malay Archipelago. *Mangkasar* is a Malay term properly applied to the name of a people inhabiting the Celebes, although it is now the name of a Dutch seaport in the island. In the 16th and 17th centuries Celebes was called by European writers the Isle of Macaçar or Mangasar. A recent visitor reports that after considerable enquiry he finds that as far as he can discover in Macassar at the present time there is no special kind of oil either produced or prepared.

Macassar hair oil is made up now according to many fancy receipts. In America an oil of the name is merely a solution of Ylang Ylang oil (Cananga odorata) in Cocoa-nut oil.

Trade in Germany.

According to the trade reports of Messrs Gehe & Co. of Dresden, published in 1887, the oil of Schleichera trijuga appeared to have recently entered into the German market under the name of Macassar oil and was said to prove a very efficient and stimulating agent for the scalp both cleansing it and promoting the growth of the hair. The oil seeds were derived from the East, but no definite information could be discovered regarding the actual source of the seeds or the extent of the trade in them.

Trade in Calcutta.

In June 1903 a firm of merchants in Calcutta sent some of the seeds of the tree to the Reporter on Economic Products for identification. It was reported that they were called *pacca* in the vernacular and were brought from Orissa by the *Marwarees* during the months of June to September. The quantity obtainable during the previous years had been about 150 tons a year, and it was stated that the bulk of the supply was sent to Germany. They were recognised as the seeds of the *Kusum* tree from their characters which are described below, and experiments were made with the seeds and oil to confirm the results of the investigations which have been conducted on the Continent.

Possible Trade Sources.

Possible Trade Sources.

The Inspector-General of Forests supplied valuable information regarding the prevalence of the tree and possible commercial sources of the seeds.

The following replies were given to the question, "What amount is available in your circle and at what approximate cost?"

Macassar Oil. (*D Hooper.*) **SCHLEICHERA trijuga.**

Possible Trade Sources.

Bengal—Singbhum.—Possible yield per year 3,355 maunds at a cost of R1-2 to R3-4 per maund.

United Provinces—School Circle.—The cost of collecting would be 3 annas per seer.

Oudh Circle.—100 maunds at R2 per maund.

Central Circle.—15 to 20 maunds at a cost of 2 to 8 annas a seer.

Central Provinces—Northern Circle.—600 to 700 maunds a year at R2 to R3 per maund.

Central Circle.—Raipur 13,000 maunds at 10 annas per maund.

Bilaspur.—200 maunds. R3 cost of collecting and carriage to the station.

Berar.—The cost of collecting would be 1 to 2 annas per seer, every four or seven years, when the fruit is abundant.

Bombay—Northern Circle.—Impossible to estimate the amount of seed available. A few tons might be collected at about R40 per ton.

Southern Circle.—About 200 maunds of 80lbs. each could be collected for export in Kanara and 4 maunds in Kolaba. The cost of collection and delivery on the railway would be between R4 and R5 per maund.

Coorg.—The estimated outturn is 2 tons at R40 per ton.

Madras—Ganjam.—During an abundant year the seed could be delivered at Berhampur at R1 per maund.

Godaveri.—Price of seed R2 a bag of 164 lbs.

Anantapur.—200 seers could be gathered at a cost of R4.

North Malabar.—On alternate years, when the trees fruit freely, 40 maunds of 28 lbs. of seeds could be supplied at 8 annas per maund.

South Malabar.—The estimated yield of the circle is 250 powas at 6 to 7 annas a powa of 6 Madras measures.

Nilgiris.—10 to 15 tons at R30 per ton.

North Coimbatore.—500 maunds or 6 tons at R10 per maund

South Coimbatore.—one ton for R150.

Tinnevelly.—3,000 measures at 9 pies per measure.

Burma—Tenasserim Circle.—200 bags equal to 600 baskets of seed could be supplied a year, at an approximate cost of R6-8-0 per bag F. O. B., Rangoon or Moulmein.

Pegu Circle.—A mere estimate is 5,000 lbs. a year at a cost of six annas per maund.

Upper Burma—Northern Circle.—400 bushels could be procured at R1-8-0 per bushel.

Southern Circle.—Large quantities would in a good seed year be procurable, but the cost would vary greatly from place to place.

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Possible Sources of Trade.

In the Ruby Mines district it is reported that considerable quantities of seed could be delivered on the Irrawaddy at R4 a basket of 1½ cubic feet, and from the Mandalay division it could be delivered at Kyaukse, Mandalay or Meiktila railway stations at R3 a basket.

It is seen that a large quantity of seed is available in India, but owing to the seed being edible, jungle tribes would in times of scarcity gather the fruits for their own consumption rather than for purposes of trade. We are told by some of the Forest Officers that monkeys and parrots are partial to the seeds, and these would have to be reckoned with in many districts when estimating a crop.

Effect of lac cultivation.

A good quality of lac infests the branches of the tree to a considerable extent in Raipur and Bilaspur in the Central Provinces. In the United Provinces it is occasionally found on the trees. In Bombay it is rare, and in Madras no lac trade is reported and no insects are noticed. Lac cultivation is a very exhaustive drain upon any tree and is incompatible with the exploitation of the fruit. In other words a successful outturn of lac would mean a very poor crop of fruit. Where the lac-insect does not attack all the trees of a district it is not unreasonable to expect a harvest of seed as well as lac.

Effect of lopping.

With regard to the lopping of branches for fodder and its effect on the yield of fruit Forest Officers are almost unanimously of opinion that this practice interferes with the fruit-bearing capabilities of the tree. It has been noticed in Oudh that trees on private lands where leaves and branches are taken for fodder produce no seed. The fruits are usually produced at the ends of the branches as in other plants of the Sapindaceæ family, and it consequently follows that the custom must seriously interfere with the yield. During a time of drought the trees are severely lopped in the Panjab and no fruit is available during the year. If the lopping is done in February-March no seeds can be expected for one or two years afterwards, but in about two years the trees recover. In Garhwal it is said that the pruning of small branches within reasonable limits would probably not affect the amount of seed produced, but here as elsewhere severe lopping would certainly do so.

Uses of the oil and seeds.

USES OF THE OIL AND SEEDS.

The inhabitants of the villages and aborigines of the forests use the oil for ordinary domestic purposes. As an illuminant and for cooking it is employed in Bengal, Bombay, Burma, Madras, Travancore, United Provinces and Central Provinces, as a hair oil in the United Provinces and Dangs of Bombay.

In the Nilgiris the oil is used for anointing the body. The medicinal effects are variously reported as purgative (in the United

USES OF THE OIL AND SEEDS.

Provinces) and as prophylactic against cholera (in Thana division, Bombay). It is more usual to apply it externally in massage for rheumatism (Bombay), for the cure of headache (Sambalpur, Central Provinces). Its application in Bombay, Malabar, and Coorg is said to be effective in removing itch and other forms of skin diseases, and this remedy is known to the wild forest tribes. The powdered seeds are applied to ulcers of animals and for removing maggots.

No oil is sold or exported in any of the districts.

Notwithstanding the peculiar taste of the ripe fruits and seeds they are eaten by local tribes of the United Provinces, Central Provinces, Bombay (Bhils and Panch Mehals), Burma (Tenasserim), Madras (Coimbatore). In Berar the seeds are regularly eaten, and largely consumed in times of scarcity or famine.

The Seeds.

The seeds.

The seeds are ovoid or rounded in shape, about five-eighths of an inch long by half an inch broad, smooth, reddish-brown in colour, and marked with an indented hilum at one end. One hundred seeds weigh 57 grams giving an average weight of 8·7 grains per seed. On removing the brown, brittle shell a dirty white kernel is disclosed with white markings on the testa. One hundred parts of seeds afford 66 parts of kernels and 34 parts of shells. The kernels extracted with ether or petroleum spirit yielded in the Museum laboratory 61·4 per cent. of oil, showing that the entire seed contains 40·5 per cent. of oil.

Mr. J. H. Walker of the Oil Department of the Gouripore Company, Naihati, obtained a yield of 60·4 per cent. of a thick fixed oil from the kernels, which is equivalent to 36·7 per cent. on the nuts.

Composition of seeds and oil.

COMPOSITION.

The first analysis of the seeds appears to have been made by Dr. L. Van Itallie [*Apoth. Zeitung.* (1889), 4·506], who separated about 36 per cent. of a buttery fat, which he called the Macassar oil of commerce. It had a specific gravity of 0·924 at 15° C., melted at 28° C., had an iodine number of 53, a saponification equivalent of 219 (1 gram required 230 mgm. of potash for saponification), contained 91 per cent. of insoluble fatty acids and 6·3 per cent. of glycerol. The fatty acids present included acetic, butyric lauric, arachic and oleic acids. Van Itallie's analysis.

The next recorded analysis of Macassar oil is that of Dr. K. Trümmel [*Apoth. Zeitung.* (1889), 4·518]. The oil had a melting point of 21°-22° C. The presence of hydrocyanic acid was detected and 0·47 per cent. obtained by steam distillation. Benzaldehyde Trümmel's analysis.

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SCHLEICHERA trijuga. | Paka seeds as the source of

COMPOSITION.

was detected in the distillate by its transformation into benzoic acid by the action of potassium permanganate.

Dr. Trümmel in conjunction with Mr. Kwassiok further investigated the oil in 1891 (*Pharm. Zeit.* May 1891, 314), after confirming previous results the authors separated the constituents of the oil. The fatty acids, with the exception of 3·15 per cent. of free oleic acid, were present as glycerides. Of these in combination 70 per cent consisted of oleic acid, and of the solid fatty acids 5 per cent. was palmitic and 25 per cent. arachic acid, the characteristic acid of the ground-nut. Lauric acid was not present, and of the volatile fat acids only acetic and no butyric acid could be detected. Hydrocyanic was found in the oil and in the seeds, being determined as 0·03 per cent. in the former and 0·62 per cent. in the latter. No amyadalin could be detected in the seeds, but hydrocyanic, benzaldehyde and grape sugar, possibly the decomposition products of it, were found. A small quantity of cane sugar was also separated in the crystallised form.

Glenk's analysis.

In 1893 an examination was made by Mr. R. Glenk (*Amer. Journ. Pharm.* LXV. 528) of a specimen of the oil from seeds sent from Mirzapur. The oil was described as a yellowish-white semi-solid substance having a faint odour of bitter almonds and a specific gravity of 0·942. The oil had an acid re-action, and completely liquified at 28° C. It was readily saponified by sodium hydrate even at a low temparature, forming a white hard soap. Concentrated sulphuric acid acquired a reddish-brown colour on addition of the oil. It is soluble in chloroform, ether, bisulphate of carbon, benzene, and the fixed and volatile oils.

Wijs' analysis.

Dr. J. J. A. Wijs examined the seeds in 1900 (*Zeits. physic. Chem.* 31·255—257). The seeds of Schleichera trijuga were obtained from the Celebes, and 60 per cent. consisted of kernels. The kernels had the following composition:—

Water	3·5
Fat	70·5
Proteids	12·0
Fibre and ash	14·0
	100·0

The fat extracted by means of petroleum ether had the colour and consistence of butter. The following constants were determined: melting point (by the Le Sueur and Crossley method), 22° C.; melting point of the fatty acids, 52—54° C.; Hehner value, 91·55; saponification value (Henriques' cold process), 215.3; iodine value (Wijs' iodine chloride and acetic acid method), 55·0, that of the fatty

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acids being 58·9; Reichert-Meissl value, 9; acid number, 19·2; acid number of the fatty acids, 191·2—192·0; unsaponifiable matter, 3·12 per cent. The volatile acids (acetic acid with a little butyric acid) were examined by the Duclaux method; and the ratio of the solid (45 per cent.) to the liquid fatty acids (55 per cent. with iodine value 103·2) was determined by the Rose method. COMPOSITION.

In the Indian Museum two samples of *Kusum* oil are exhibited; one was from Palamou and had been presented to the Agri-Horticultural Society of India in 1845, the other was from Goomsuti and was formerly the property of the Asiatic Society of Bengal. The oils had high acid values of 26 and 26, iodine values of 129 and 90·6 and melting points of fatty acids 35 and 36 respectively. A sample from Angul gave an acid value of 10·42, iodine value, 56; and melting point of fatty acid, 48. The samples had the odour of oil of bitter almonds notwithstanding the time they had been kept in the Museum.

Timber.

The wood is hard, more or less bent, strong and durable. In colour it is light reddish-brown (heart wood) and whitish (sapwood). The timber is much used for making pestles, cart wheels, naves and axles, ploughs, and the teeth of harrows, also for rollers of sugar mills and of cotton and oil presses. Weight per cubic foot 70 lbs. Timber.

A fitting conclusion to the information contained in the report will be found in the following note on the tree drawn up by the Inspector-General of Forests:—

"The tree is only of local value at this moment. Before the introduction of the iron roller cane mills there was a very large export of the timber for sugar presses for which purpose its hardness and toughness suits admirably. Since that time, however, although the seeds are used for oil, the twigs for lac feeding, the flowers for dye, I believe, sometimes, the chief value of the tree has been lost. I have no doubt that these persons who use the oil do so because it happens to be to them the cheapest available, but not for any special quality." Conclusion

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place according to the letter and number shown at the bottom of each page.

(Vegetable Product Series, No. 90.

THE

AGRICULTURAL LEDGER.

1905—No. 2.

PHASEOLUS LUNATUS.

(LIMA OR DUFFIN BEAN.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. VI., Pt. I., pages 489-492.*]

A report on the Chemical examination of the beans, by WYNDHAM R. DUNSTAN, F.R.S., *Director of the Imperial Institute, London.*



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1905.

AGENTS.

In Britain.

[illegible] Street, [illegible]

Messrs. Kegan Paul, Trench, Trübner & Co., Charing Cross Road, London.

Mr. Bernard Quaritch, 15, Piccadilly, London.

Mr. B. H. Blackwell, 50 & 51, Broad Street, Oxford.

Messrs. Deighton Bell & Co., Cambridge.

Messrs. Henry S. King & Co, 65, Cornhill, and 9, Pall Mall, London.

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Higginbothan & Co, Madras.

G. A. Natesan & Co, Madras.

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Superintendent, American Baptist Mission Press, Rangoon.

Rai Sahib M. Gulab Singh & Sons, [illegible] Press, Lahore.

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N. B. Mathur, Superintendent, Nazair-kanun-Hind Press, Allahabad.

THE AGRICULTURAL LEDGER.

1905—No. 2.

PHASEOLUS LUNATUS.

(LIMA OR DUFFIN BEAN.)

[*Dictionary of Economic Products, Vol.* VI, Pt. I, pages 489-492.]

A report on the Chemical examination of the beans, by WYNDHAM DUNSTAN, F.R S, *Director of the Imperial Institute, London.*

The following information on this plant, gathered since the article on **Phaseolus lunatus** was written for the *Dictionary of Economic Products*, will be of some interest as an introduction to Prof. Dunstan's report.

Phaseolus lunatus, *Linn.* Lima or Duffin Bean.

Vern.—*Kursumbulle-pullie*, Hind ; *Bimbur-butti, ma*, Beng.; *Tik-bit-zim, kerow-simbi, lum takbit*, Sikkim; *Kataridabooa mah, bangala mah, urahi*, Ass.; *Udadyaweli*, Ali Rajpur; *Pegyi, pegya, pe-ta-la, pe-saulagu*, Burm ; *Koro-mas*, Java.

Habitat.—The Lima bean is said to be indigenous to South America, but it has long been cultivated in most of the warmer parts of the earth. Bentham refers to wild specimens from the Amazon basin and central Brazil. They belong specially to the large variety (**macrocarpus**) which abounds in the Peruvian tombs of Ancon. It was probably introduced into Guinea by the slave trade and spread thence into the interior and coast of Mozambique. It is cultivated nearly throughout tropical Africa. However, Schweinfurth and Ascherson do not mention it for Abyssinia, Nubia, or Egypt. Habitat.

In India it is found in Assam, Bengal, Burma and the Panjab. It is a scanty bearer on the hills and plains of the United Provinces, and is not an established garden crop. It grows in Southern India, but is rarely met with.

PHASEOLUS lunatus.	A report on the Chemical

Habitat.

It has long been cultivated in Australia where it is known as the Dwarf or Bush Lima bean. In 1896 it was introduced into New South Wales from the Tonga Islands, and is known as the Tongan bean. It climbs to the tops of shrubs and trees and forms a pretty vine for covering trellis or out-houses. An interesting paper on the cultivation of the Bush bean will be found in the *Agricultural Gazette of New South Wales*, Volume III, Part II, 1892, 644. The Lima bean is also cultivated in California. Professor L. H. Bailey, of the Cornell University wrote an account of its cultivation and uses in 1896.

Uses

Uses.—The legumes or pods of this plant are not used as an esculent. The ripe seed are eaten, and they should be cooked in a similar way to haricots or broad beans. When properly served up they are much superior to either of these pulses (Turner). It is used as a fodder plant by the natives of the Tonga Islands, and the white population appreciate the beans, which are cooked like French beans, or shelled like peas when nearly matured. The green pods may be picked, and the beans shelled out and dried, and these can be used in the winter time to as good advantage as if they were thoroughly ripe. If these dried beans are soaked in water for some time before they are cooked they are scarcely inferior to green beans direct from the vine (Bailey).

In Assam the seeds are eaten, either raw or fried in oil or boiled in water.

Chemical Composition.

Chemical Composition.

The composition of the beans is thus represented. The first analysis is that of a white seeded variety from Mysore made by Dr. Church, in 1886; the second is that of the seeds grown in Java made in the Haarlem Museum, Holland, in 1900.

	Mysore.	Java.
Water	13·3	14·85
Albuminoids	19·7	21·00
Carbohydrates	57·8	36·88
Oil	1·2	0·60
Fibre	4·3	3·66
Ash	3·7	3·33

The poisonous action of the seed has been observed for many years and fatal effects have often followed the consumption of the raw beans. Van Romburgh in 1897 (*Mededeelingen uits lands plantentuin*, Vol. 29, page 56) referred to their toxic nature in the island of Réunión. He stated that the seed contained an amygdalin like glucoside which on decomposition yielded 0·25 per cent. of hydrocyanic acid. The leaves also gave on distillation with water hydrocyanic or prussic acid and acetone.

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Chemical Examination.

Professor Dunstan's report will give the history of the investigations down to the present time. The paper is entitled :—

Report on the chemical examination of the Beans of Phaseolus lunatus grown in India, by Professor Wyndham R. Dunstan, M.A., F.R.S., Director.

Origin of poisonous property.

An investigation into the cause of the occasional toxicity of various fodder plants has been carried on in the Scientific and Technical Department of the Imperial Institute during the last few years. In the course of this work it has been shown that in a number of cases the poisonous nature of these materials is due to the presence of glucosides, which are decomposed by soluble ferments, also present in the plants, with the production of prussic acid, which acts as the poison. Full accounts of the chemistry of a number of these glucosides and of the reactions resulting in the formation of prussic acid from them have been given in the series of papers enumerated below, which have been communicated to the Royal Society by Professor W. R. Dunstan and Dr. T. A. Henry.

Previous papers.

No. 1. "Cyanogenesis in Plants Part I. The Nature and Origin of the Poison of *Lotus arabicus*." Transactions of the Royal Society, 1901, 194 B, 515

No. 2. "Cyanogenesis in Plants. Part II. The Great Millet. *Sorghum vulgare*" Transactions of the Royal Society, 1902, 199 A, 399.

No. 3. "Cyanogenesis in Plants Part III. On Phaseolunatin or the Cyanogenetic Glucoside of *Phaseolus lunatus*" Proceedings of the Royal Society, 1903, 72, 285

Copies of these papers have been sent to the Officiating Reporter on Economic Products to the Government of India, and an abstract of No. 3 has been published in India, as "Commercial Circular No. 2 of 1903," under the title of "Lima, Duffin, Rangoon, or Paigya Bean—Phaseolus lunatus." In this Circular, attention is drawn to the desirability of ascertaining whether some varieties of this bean should be cultivated in India in preference to others.

Sorghum vulgare.

Reference may also be made here to the report dated the 19th January 1905, already sent to the Officiating Reporter on Economic Products, giving the results of the chemical examination at the Imperial Institute of a number of samples of Indian Sorghum vulgare, from the same point of view.

The first specimen of the beans of Phaseolus lunatus examined at the Imperial Institute came from Mauritius where the plant is grown in a practically wild state and used as a green manure. A number of cases in which cattle had been poisoned as the result of eating the plant had been recorded in Mauritius, and in 1898 Mr. Boname, Superintendent of the Botanic Station in the . . .

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PHASEOLUS lunatus. A report on the Chemical

Chemical Examination.

showed that the whole plant produced prussic acid when ground up in contact with water, the largest amount of the acid being obtained from the seeds, and that the toxicity was due to the formation of this substance.

The results of the investigation of the Mauritius beans at the Imperial Institute may be briefly summarised in the statement that they were shown to contain a cyanogenetic glucoside, to which the name *phaseolunatin* was given, and an enzyme probably identical with the *emulsin* of almonds. It was further shown that when these two substances were brought into intimate contact, *e.g.*, by grinding the beans with water, the glucoside was decomposed by the enzyme, yielding acetone, dextrose and prussic acid. The amount of prussic acid so obtainable from the Mauritius beans varied from 0·04 to 0·09 per cent. by weight, the largest quantity being found in the seeds having a dark purple-coloured testa and the smallest amount in those having a pale cream-coloured or almost white testa.

Cyanogenetic glucoside.

Phaseolus lunatus is generally stated to be indigenous to South America (whence the name Lima-bean by which the white bean, apparently produced only by carefully cultivated plants, is sometimes known) but it has been introduced into most tropical and sub-tropical countries and is widely grown for edible purposes throughout the East Indies.

In partially or wholly cultivated forms the testa of the bean is either pink with a few purplish spots, pale cream-coloured or even quite white. These forms of the bean are undoubtedly less poisonous than the almost wild type grown in Mauritius, but even with the cultivated varieties cases of poisoning occurred and attention has been directed to their toxicity by various authors, thus Watt, *Dictionary of Economic Products of India*, Volume VI, I, 187, states that " It is well to remember that this species sometimes exhibits markedly poisonous properties," and Church, *Food Grains of India*, page 155, says : " This is one of the species of Phaseolus which sometimes exhibit marked poisonous properties. It is desirable that great care should be taken in selecting for cultivation only the best variety of Lima-beans. The large oval white-seeded kinds with, at the most, a brown or black mark at the hilum are preferable to those with flattened rather uniform seeds having blotches of red or veinings of black."

White seeds preferred

Burma beans.

Whilst the investigation of the Mauritius beans was in progress at the Imperial Institute there were imported into this country from India large quantities of beans variously described as Rangoon, Burma or Paigya beans intended for use in preparation of feeding-stuffs for cattle. Samples of these beans were sent to the Imperial Institute by a number of firms in various parts

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of the country with a request for information as to their identity and their suitability for use as a feeding-stuff. Chemical Examination.

These beans closely resembled those produced by the semi-cultivated forms of Phaseolus lunatus, the testa varying in colour from white to pale pink with a few purple spots. They were chemically examined and it was found that the white beans, which were as a rule present only in small quantity, yielded no prussic acid, whereas the coloured ones yielded from 0·004 to 0·009 per cent. of the acid. Plants were eventually grown from some of these samples of Burma beans and were identified as Phaseolus lunatus. No poison in white beans.

Preliminary accounts of these investigations on Rangoon beans were published in the "*Bulletin of the Imperial Institute,*" Volume 1, 1903, pages 16 and 115, and, in these articles attention was directed to the fact that although the amount of prussic acid obtainable from the coloured beans was in most cases probably insufficient to be dangerous to cattle, yet in view of the fact that the amount of the acid formed varied with different specimens of seed, it seemed desirable that the use of this material as a feeding-stuff should be attended with caution until it had been ascertained precisely under what conditions it was poisonous. A food for cattle.

In the meantime application had been made in a letter, dated the 18th December 1901, to the Reporter on Economic Products to the Government of India for authentic samples of the beans of Phaseolus lunatus grown in India so that the investigation carried out with the Mauritius beans might be repeated on this material. In compliance with this request a sample of these beans was sent to the Imperial Institute by the Officiating Reporter on Economic Products under cover of a letter (F. S. 2987—144), dated the 11th December 1902. Indian seeds.

This sample was examined in the Scientific and Technical Department of the Imperial Institute and gave the following results.

Description of sample.

The sample was labelled "Phaseolus lunatus beans from Pokakku District, Burma." The beans were light brown in colour with a few purple spots and closely resembled the Burma or Paigya beans imported into this country. From Burma

Results of Chemical Examination.

The amount of prussic acid yielded by the beans was determined by grinding them into a fine powder and extracting this with alcohol, in which the glucoside is soluble and the enzyme insoluble. The alcohol was then distilled off and the glucoside, left in the residue, was decomposed by boiling it with hydrochloric acid. The prussic

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Chemical Examination.

acid so produced was distilled off and estimated. It was found as the mean of a number of experiments carried out in this way that this sample of beans yielded 0·009 per cent. of prussic acid. Along with the acid, acetone was invariably found in the distillate, and the simultaneous presence of both these substances left little doubt that the seeds contained phaseolunatin.

General Conclusions and Recommendations.

Conclusions

These results show that although the seeds of Phaseolus lunatus, as grown in Burma furnish less prussic acid than those produced in Mauritius, they still yield a sufficiently large proportion of this poison to render them undesirable for consumption, at any rate in the raw state.

It has been urged that the quantity of prussic acid produced by these semi-cultivated varieties of Burma beans is so small that they may be regarded as innocuous. It is impossible to say without actual trial whether the continuous consumption by animals of material yielding a small amount of prussic acid would be injurious or not. Apart from this difficulty there is the possibility of great variation in the amount of prussic acid produced by these beans. Experience with the Mauritius beans has shown that the amount of prussic acid *obtainable may vary widely, and in the more limited* experience with the Indian beans similar variations have been observed. Since the causes of these variations are at present unknown and therefore uncontrollable, it is possible that as the result of some slight change in the method of cultivation or under abnormal climatic conditions, the quantity of prussic acid obtainable from these semi-cultivated seeds from Burma might give rise to amounts of the poison corresponding with those obtained from the light coloured Mauritius varieties, as to the toxicity of which there can be no question.

Prussic acid variable.

The Indian trade in leguminous seeds suitable for feeding-stuffs is already large and is steadily increasing, and it is therefore necessary for those concerned in the export of these commodities to exercise care in selecting new grains for export.

Selection.

It is obvious that much harm would be done to this branch of Indian trade if by any chance consignments of poisonous beans were exported and distributed in the ordinary way.

White beans to be cultivated.

It seems advisable therefore that if possible the cultivators of this material for export should be advised to cultivate the perfectly white beans rather than the coloured varieties, which are now shown not to be above suspicion.

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G. I. C. P. O.—No. 811 R. E. P.—11-7-1905—2,500—J. W. G.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

(Mineral and Metallic Series, No. 22.)

THE

AGRICULTURAL LEDGER.

1905—No. 3.

SALTPETRE.

(NITRE, POTASSIUM NITRATE.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. VI., Pt. II., S. 681—704.*]

A Report on the Manufacture and Composition of Indian Saltpetre
by DAVID HOOPER, F.I.C., F.C.S.



CALCUTTA:
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1905.

THE

AGRICULTURAL LEDGER.

1905—No. 2.

SALTPETRE.

(NITRE, POTASSIUM NITRATE.)

[*Dictionary of Economic Products, Vol. VI, Pt. II, ...*]

A REPORT ON THE MANUFACTURE AND COMPOSITION OF INDIAN SALTPETRE, BY DAVID HOOPER, F.I.C., F.C.S.

The Inspector General of Agriculture in India in 1904 instituted an enquiry regarding the distribution of nitre deposits in India and the methods of manufacture adopted in separating and refining the salt. This was undertaken to show ways and means of reducing the cost of this salt so as to permit of its being used more extensively as manure either as crude saltpetre or in a purer form. The following notes on the subject are drawn up from observations ... saltpetre-bearing districts, and from information ... Agricultural Depa...

special reference to this country, ... occur and where the salt is manufactured are then enumerated. The manufacture of saltpetre is described, and tables are given of the analyses of numerous samples of nitrous earth, crude and refined saltpetre, impure and purified table salt and other by-products.

Nitrification.

It has long been known that when animal and vegetable matters containing nitrogen decay in earth impregnated with wood-ashes or lime, nitrates of potash and lime are formed. In warm climates especially there are numerous localities where the soil is highly charged with nitrates. This is not only true of India but of Egypt,

S.

Nitrification. Poland, Hungary, Italy, Turkey, Burma, Tibet, Turkistan, Sumatra and Brazil. In each of these countries earths occur which are rich enough in saltpetre to pay the cost of working. In all these places the nitrate of potash appears to have resulted from the decomposition of organic remains, and is found chiefly on the sites of former habitations. The water of wells in crowded cities usually contains nitrogenous compounds originating from the soil and subsoil being contaminated with sewage and other nitrogenous organic matter. The nitrification occurs in the surface soil in contact with air and in the presence of an alkaline base such as lime, magnesia, potash, or soda. Usually there is enough carbonate of lime in soils to promote the action. Schlossing, performing some careful experiments in this subject, found that ammonia mixed with moist loam changed completely into nitrates in a fortnight. The processes of nitrification are caused by microscopic organisms termed bacteria or bacilli. One class of bacteria, according to Winogradsky, converts the ammonia into nitrous acid and are called nitrous ferments, and the other changes nitrous acid into nitric acid and are termed nitric ferments.

The following are some of the more important conditions favourable to the work of the nitrifying bacteria :—

Temperature. (*a*) *Temperature.*—The formation of nitrates becomes active at 54° F., and increases as the temperature rises above that point until it reaches 98° to 99° when nitrification is at its maximum. Under suitable conditions, other things being equal, 10 times as much saltpetre can be obtained at 99° as at 54°.

Moisture. (*b*) *Moisture.*—Water is indispensable in the formation of nitrates. Drought will retard the process, and severe drought stop it. Absence of rain for two or three seasons in certain Panjab saltpetre districts has caused a short supply. Water conveys the potash and lime bases to the scene of action where the bacteria are at work. It holds saltpetre and other salts in solution, and as it evaporates throughout the hot season brings these salts to the surface of the soil.

Oxygen. (*c*) *Oxygen*—Is essential, hence air must gain free admission to the surface soil as the process goes on. In the refineries the caking mud caused by throwing the dissolved by-products on the earth is broken up to allow of sufficient aëration.

Darkness. (*d*) *Darkness*—Is believed to be favourable for the formation of saltpetre. In manufactory yards in India the nitre earth is kept in sheds; this is not only to keep off the rain but the

Nitrous earth.

goes on in the warm moist surface soil, to which conservancy refuse and other nitrogenous organic matter has been added. The soil's natural supply of necessary inorganic bases is increased by the people throwing fuel ashes outside their dwellings. During the dry season, commencing in November, the soluble products of the nitrifying bacteria rise to the surface by capillary attraction. This nitrous earth differs from the white *reh* efflorescence so commonly seen in the United Provinces and the Panjab. It is of darker colour, and if scratched with a nail or knife white specks of nitre crystals are visible to the naked eye, and the earth, if placed on the tongue, has a cool, saline taste. This incrustation with the soil to the depth of half an inch is the nitrous earth or *lunamati* or *mitishora* of Indian saltpetre manufacturers

Composition of nitrous earth.

Analyses of the nitrous soils of the Hathwa Raj, Bengal, were made from month to month from February to May and were found to have a similar composition. This indicates that in this district the constituents remain the same during the continuance of the dry weather. Another series of analyses was made of soils taken at various depths immediately after the rainy season. A complete analysis being made of each sample, it was shown that the soluble salts, of which potassium nitrate was the most abundant, existed in a larger amount above 6 inches below the surface of the earth. The nitrates rise to the surface after a short time, but at the depth of 12 inches at two different sites there was no indication of nitrates and an almost entire absence of other soluble salts. Lime and phosphoric acid were noticeable in all the soils, but organic matter and ammonia were in small amount.

The two sub-joined columns give the analyses of nitrous soil from Bengal. The first was made by the author and the second by Drs. Boekhout and Otto de Vries, of the Rijkslandbouwprefstation, Hoorn, Holland.

Water	9·01	3·3
Organic matter	6·22	·5
Iron oxide	3·52	4·0
Alumina	3·82	8·0
Lime	5·67	9·7
Magnesia	·86	...
Potash	1·87	1·0
Soda	1·26	1·7
Phosphoric acid	·22	·26
Sulphuric acid	·97	2·3
Chlorine	·30	·8
Nitric acid	2·00	*
Carbonic acid	3·83	...
Silica and sand	60·40	50·8

* Total nitrogen 0·29 (Jodlbaur), 0·30 (Dumas), nitric nitrogen 0·22, albuminoid nitrogen 0·08 per cent.

Nitrous earth.

Seventy-two samples of nitrous earth were chemically examined. The results are exhibited in tabulated Statement I which discriminates between various classes of samples. The composition of the samples is exceedingly variable. The salt consist of nitrates, nitrites, chlorides and sulphates of potassium, sodium, magnesium and calcium. They have an alkaline reaction, and in a few cases evolve a slightly ammoniacal odour. The two samples, Nos. 96 and 97, from Cawnpore, and one, numbered 421, from Lahore, were not used for saltpetre making but for manures in gardens. Nitrous earth is not uncommonly used as manure in parts of the Panjab, United Provinces, Sind, and Bengal. The particular samples referred to are superior for nitre production to some others in the tabulated list, but could have only been economically used locally as manure. The cost of transport to any distance would have been prohibitive, as they only contained about half the amount of nitrogen found in ordinary samples of farmyard manure.

Valuation.

The total percentage of salts in the various samples varies from 36·22 to 1·49, whilst the percentage of nitrates varies from 22·57 to ·64. The true value of a nitrous soil to the saltpetre manufacturer depends more upon the quantity of nitrates in the salts than on the salts in the soil. An effort was made to obtain, from each locality, samples which in local opinion were considered good, middling, and inferior. These particular samples are grouped in the statement collectively. Actual analysis showed that in some cases local opinion was right, in other instances it was very wide of the mark. In the light of this evidence we are led to the conclusion that the value of nitrous earth cannot be estimated merely by its appearance.

As regards the earths from Okara in the Panjab, the local valuation was right The samples yielded of potassium nitrate—

	Per cent.
Good	12·58
Middling	6·10
Inferior	3·81

In samples from Farukhabad, Bhawani, and Sirsa the supposed superiority is attributable more to the abundance of the saline matter than to the yield of nitrates. As regards samples from other districts those which were classed as inferior or middling were actually found superior to those appraised as good.

There is clear evidence that the nitrous earths obtainable in some districts are of high value for the production of excellent saltpetre, and are very much superior to those found in other districts. Fuller enquiry is required to determine relative values in a reliable way, and also differences in value between samples of the same districts collected at various times during the manufacturing season.

Nitrous earth.

Samples 542 to 558, which form the fourth group of the tabular statement, were collected to throw light on the latter point, but the figures are contradictory and do not exhibit any progressive increase or decrease of value.

It should be noticed that nitrous earth frequently contains stones and pieces of broken pots, etc., owing to the fact that it is collected mostly from the sites of old habitations. The larger pieces are removed by the worker because they interfere with filteration. Samples 434 and 457 were of this class. The analyses 434 A and 457 A represent that of the finely sifted earth removed from the coarse impurities of the original samples.

Factory soil.

Samples 64 to 72 of the 5th and 6th groups of the statement represent "Refinery earth" or "Factory soil," and these should be distinguished from ordinary nitrous earth. The manufacturer spreads his exhausted nitrous earth in his yard, and on it are thrown from time to time the skimmings from the boiling saltpetre solution, such mother-liquor as can be spared or is supersaturated with inferior salts, the ashes from the fire-places, and all other waste products from the factory. These are absorbed by the soil of the yard which is stirred to secure admixture and aëration. The samples of factory and refinery earths were obtained from these yards Some of the samples were collected in the open yards, others in closed sheds. They are naturally of variable composition.

STATEMENT I.—*Analyses of nitrous earths.*

Serial No.	Source of Sample	Register No. of sample in the office of the Agricultural Chemist	Nitrates of Potassium, Lime and Magnesium.	Chloride Sodium	Sulphate Sodium	Total Salts.	Nitrogen in Nitrates.	Remarks.
			Per cent.	Per cent	Per cent.	Per cent.	Per cent.	
1	Cawnpore	96	3·60	1·99	1·95	7·54	·49	Nitrous earth directly used as manure.
2	"	97	2·29	2·85	3·60	8·74	·33	
3	Lahore	421	2·67	4·82	5·02	12·51	·45	
4	Shahawar, Etah, good . .	432	6·28	2·01	·97	9·26	1·00	Nitrous earths from various districts classed locally as good, middling, inferior, or 1st, 2nd, and 3rd quality.
5	" " middling .	433	9·49	2·42	1·17	13·08	1·43	
6	" " inferior . .	434	1·17	·50	·50	2·26	·16	
7	" " " . .	434*a*	1·86	1·00	·78	3·64	·27	
8	Muttra, good . . .	457	2·96	1·50	·90	5·36	·46	
9	" " . . .	457*a*	6·04	2·73	1·29	10·06	·90	
10	" middling . . .	458	6·65	5·35	·98	12·98	·97	
11	" inferior . . .	459	9·08	4·20	1·32	14·60	1·33	
12	Sewan, Saran, good . .	649	7·11	3·85	·50	11·46	1·23	
13	" " inferior . .	650	2·80	1·38	1·45	5·63	·50	
14	Hardoi, quality I . . .	871	4·68	4·35	4·05	13·10	·79	
15	" " II . . .	872	7·68	7·06	3·98	18·72	1·22	
16	" " III . . .	667	4·59	5·18	5·44	15·21	·80	
17	Farukhabad, quality I . .	672	7·48	11·67	10·17	29·32	1·27	
18	" " II . .	875	7·42	10·67	8·79	25·88	1·21	
19	" " III . .	673	3·32	4·22	5·24	12·78	·57	
20	Gurwa, Ghazipur, good . .	677	9·41	5·26	·59	15·26	1·58	
21	" " middling .	678	13·95	4·48	2·15	20·58	1·30	
22	" " inferior .	679	12·39	3·80	1·95	18·14	2·10	
23	" " good . .	683	2·01	1·03	1·36	4·40	·33	

STATEMENT I.—*Analyses of nitrous earths.*

Serial No.	Source of Sample.	Register No. of sample in the office of the Agricultural Chemist.	Nitrates of Potassium, Lime and Magnesium.	Chloride Sodium.	Sulphate Sodium.	Total Salts.	Nitrogen in Nitrates.	Remarks.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
24	Gurwa, Ghazipur, middling	684	4·59	4·34	·59	9·52	·76	Nitrous earth from various districts classed locally as good, middling, inferior, or 1st, 2nd, and 3rd quality.
25	" " inferior	685	·64	·14	·71	1·49	·11	
26	Okara, Montgomery, good	715	17·87	8·03	5·94	31·84	2·66	
27	" " middling	716	9·03	7·36	2·60	19·04	1·36	
28	" " inferior	717	9·60	10·15	3·73	23·48	1·56	
29	Bhawani " good	725	29·57	10·78	4·87	36·22	3·06	
30	" " middling	726	6·89	4·66	7·77	19·32	1·10	
31	" " inferior	727	3·73	4·17	5·04	12·94	·59	
32	Sirsa, Hissar, Panjab, good	733	6·66	6·84	4·40	17·90	1·02	
33	" " " middling	734	8·04	5·45	·65	14·14	1·23	
34	" " " inferior	735	4·53	1·82	1·45	7·80	·71	
35	Bhera, Shahpur, Panjab, good	740	13·08	14·26	6·46	33·80	2·28	
36	" " " middling	741	9·92	9·31	2·63	21·86	1·60	
37	" " " inferior	742	2·41	1·82	1·76	5·99	·41	
38	Muswanpur	381	6·93	2·24	·57	9·80	1·08	
39	Jajmou	383	2·75	2·21	2·62	7·58	·42	
40	Hansi	435	4·25	2·27	1·12	7·04	·70	
41	Hansi Castle	439	3·99	1·73	·60	6·32	·60	
42	Alinagar, Benares	690	6·53	2·66	·45	9·64	1·02	
43	Fatehpur	697	6·18	2·90	·92	10·00	1·00	
44	Bidakhar, Hamirpur	703	16·22	3·97	·41	20·60	2·51	

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45	Chaki, Jalaun	707	4·42	1·36	·20	5·98	·73	Ordinary samples of nitrous earths obtained from various districts. The first three samples represent good, middling, and inferior samples collected when season had fairly begun; the remainder collected in the same place at intervals during manufacturing season.
46	Mahgaon, Allahabad	709	3·42	1·85	1·29	6·56	·54	
47	Andakila, Saran	747	1·69	1·30	·48	3·47	·20	
48	Lalganj, "	748	1·25	·69	1·56	3·50	·21	
49	Jahanabad, "	779	1·06	·26	1·45	2·77	·17	
50	Muzaffarpur	758	2·59	·98	1·43	5·00	·44	
51	Barhanpura, Muzaffarpur	759	3·02	1·68	1·62	6·32	·49	
52	Dokra, "	760	·92	·60	1·23	2·75	·17	
53	Gujrat, Panjab	820	3·28	1·43	·65	5·36	·51	
54	Siripur, Saran, good	542	1·13	·70	·88	2·21	·18	
55	" " middling	543	1·21	·85	1·23	3·29	·19	
56	" " inferior	544	4·97	2·61	7·32	14·90	·90	
57	" " 1st February	552	2·50	1·17	1·85	5·52	·41	
58	" " 15th "	553	1·96	1·29	1·07	4·32	·29	
59	" " 1st March	554	2·22	1·58	1·68	5·48	·37	
60	" " 10th "	556	1·11	1·16	·78	3·04	·15	
61	" " 1st April	557	2·96	1·68	2·08	5·72	·48	
62	" " 16th "	557	2·11	1·45	1·52	5·08	·37	
63	" " 1st May	558	2·21	1·45	1·46	5·12	·36	
64	Dindialpur, refinery earth (closed shed).	654	4·80	4·14	·83	9·82	·72	Refinery earth collected in open yards and in closed sheds.
65	Dindialpur, refinery earth (soil from exposed yard).	655	8·85	6·43	3·68	18·96	1·44	
66	Barhanpura refinery earth (from yard).	761	5·32	3·35	6·88	15·73	·93	
67	Barhanpura refinery earth (from inside shed).	763	1·97	1·47	2·04	5·48	·32	
68	Kheora (1st Factory) earth	389	3·06	2·84	2·86	8·76	·48	Ordinary samples of factory site earth.
69	" (2nd ") "	395	13·47	8·03	3·32	24·82	2·06	
70	Hansi (Factory soil)	436	5·30	4·14	3·72	13·16	·71	
71	Shahzadpur, Allahabad (refinery).	710	4·26	2·49	2·75	9·50	·74	
72	Parsanni refinery earth	762	1·63	1·24	2·31	5·18	·27	

STATEMENT II.—*Analyses of samples of crude saltpetre*—continued.

Serial No.	Source of Sample	Register No. of the sample in the office of the Agricultural Chemist.	Moisture.	Nitrate Potassium.	Chloride Sodium.	Sulphate Sodium.	Nitrate Calcium.	Nitrate Magnesium.	Insoluble.	Nitrogen.	Value at one anna per unit of Potassium Nitrate.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	R a.	
29	Andakilar, Saran, R2-8	751	9·30	42·40	37·70	3·40	1·28	5·32	·60	7·07	2 8	Valued at certain rates per maund of 82⅞ lbs.
30	Jahanabad, Saran, R2-12	752	6·10	57·42	26·68	9·20	...	...	·60	7·92	3 8	
31	Lalganj, Saran, R3	753	7·50	48·42	39·44	4·64	...	tr.	4·64	6·68	3 0	
32	Muzaffarpur, Saran, R2	767	7·00	49·36	16·82	14·60	3·28	7·44	1·50	8·77	3 0	
33	Mahgaon, Allahabad, R2-8	713	9·10	59·72	22·04	2·16	1·28	4·80	·90	9·36	3 8	
34	Shahzadpur, Allahabad, R2-8	714	5·80	65·56	25·52	...	...	3·12	...	9·64	4 0	
35	Allahabad (solar process, filters)	712	15·20	35·02	30·70	5·54	tr.	12·24	..	7·15	2 0	Manufactured by means of solar heat.
36	Hamirpur (solar process) R2-8	702	5·20	79·70	5·80	2·16	5·24	tr.	1·90	11·88	5 0	
37	Chak, Jalaun (solar process) R2-8	708	7·10	55·80	26·10	2·68	4·56	1·76	2·00	8·80	3 8	
38	Dumraon Farm	269	5·06	53·74	34·08	2·96	2·29	tr.	1·87	7·79	3 8	Ordinary commercial samples used as *manure* by Government farms and also obtained direct from manufacturers.
39	"	863	7·30	55·30	33·06	1·68	1·96	...	·70	7·96	3 8	
40	Burdwan	321	6·92	53·51	28·08	2·43	4·92	...	4·14	8·20	3 8	
41	Rampur State	384	2·40	67·73	19·31	4·02	1·31	4·13	1·10	10·34	4 0	
42	Siripur	545	4·90	33·73	22·34	10·73	5·90	4·80	9·60	6·51	2 0	
43	"	651	12·70	40·36	14·70	2·68	12·26	5·60	11·70	8·70	2 8	
44	"	849	9·40	37·16	11·02	18·42	7·84	1·76	14·40	6·78	2 4	
45	"	879	10·40	46·46	8·12	15·60	7·20	2·12	10·10	8·03	3 0	
46	"	880	11·80	45·08	6·38	14·60	7·84	1·60	12·70	7·85	2 12	
47	Marh, Saran	659	4·40	58·20	22·34	3·90	3·92	2·64	4·60	9·19	3 8	
48	Hakwa, Saran	661	6·20	54·00	25·20	2·92	5·24	2·64	3·80	8·10	3 8	
49	Dokra, Bihar	705	7·20	62·60	23·78	2·40	1·28	2·64	·10	9·34	4 0	
50	Barhanpura, Saran	766	3·80	68·40	17·98	3·40	2·60	2·12	·70	10·27	4 4	
51	Kheora, Cawnpore	390	3·80	47·67	28·96	8·64	1·80	7·33	1·80	8·26	3 0	
52	Malon, Kheora, Cawnpore	396	2·10	75·39	17·60	1·08	·80	2·53	·50	11·01	4 12	
53	Alinagar, Benares	693	5·10	76·47	11·76	3·16	1·31	1·60	·60	11·07	4 12	
54	Fatehpur, Allahabad	696	9·20	73·79	6·16	2·43	2·60	5·32	·50	11·63	4 8	
55	Gujrat, Panjab	819	5·00	63·20	26·32	2·43	1·31	1·04	·70	9·07	4 0	

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The Refining of Saltpetre.

The refining of saltpetre

A saltpetre refinery consists of a large fenced yard with office and godowns and sheds for the factory occupying sometimes several acres of land. One portion of the yard is covered with earth suitable for crude nitre production. When a refinery is first established nitre earth is obtained and spread on a part of the yard. The salt from the nitrous earth obtained from this area is extracted in the ordinary way with water, and the exhausted earth is spread out on this portion of the yard to receive the furnace ashes and nitrous by-products from time to time. The ashes, soil, and washings are mixed intimately, and fresh nitre is constantly generated from the "factory soil." It is a common opinion that such earth is better than new earth collected from outside. At any rate it is a continual source of crude nitre to the refiner, and it enables him to use to the best advantage all the products of his factory which otherwise might be wasted.

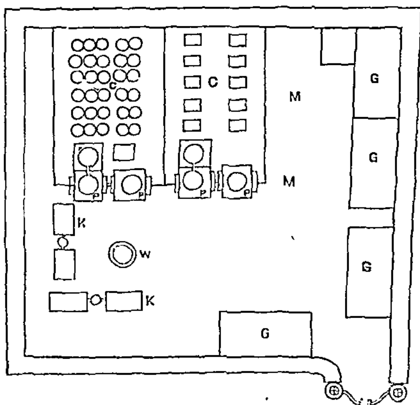
Description of refinery.

The accompanying is a sketch of a refinery at Jajmow, Cawnpore, in the United Provinces. The yard is enclosed with a high mud wall and gate. One portion of the yard (M) is covered as described above with *lunamatti* or nitre earth. At the left corner there are two pairs of filters or *kurias* (KK) for extracting crude nitre from nitrous earth. A well (W) supplies the water for this process as well as for making solutions for the refining process. There are four iron evaporating pans (PPPP) supported on masonry fire-places. Here the nitre liquor is boiled. Near each pan is another empty pan or wooden vessel to serve as a settling tank. From this the liquid is transferred to the crystallising tubs (C) arranged under the sheds. These tubs are so arranged that each day as two or more are filled, two or more are emptied, and the crystals collected. The round tubs are for making crude nitre or small refined crystals; the larger oblong vessels are for the production of the higher quality or *kalami* saltpetre. One of the most important utensils in the refinery is a boiler or iron pan for evaporating the liquor. The pan is from 10 to 12 feet in diameter, and costs *R260*; if well made, one will last ten years. It is supported on a brick-and-chunam furnace, which is 25 feet long, 15 feet broad, and 4 feet deep. Two sloping slides enable men to carry the crude nitre to the pan. In the front is the door of the furnace. At the other end nearest the sheds is a cistern of solid masonry or a spare pan. Under the sheds are arranged the crystallising vessels, which are wooden oblong tanks 7 feet long, 5½ feet broad, and 2 feet deep, where the nitre crystals form.

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Refining of saltpetre

The process followed varies in different refineries and in different parts of the country. But as the chloride of sodium is the principal impurity and as its solubility is practically constant, all the processes followed are based on the varying solubility of nitrate of potassium in hot and cold solutions.



To start a refinery, the nitre earth obtained from the factory soil is filtered in the two pairs of *kurias*. The crude nitre solution obtained from these is boiled down, clarified by sedimentation and set out to crystallize. In from six to ten days the crystals are extracted and the residual *tor* or mother-liquor is then available for future use. Crude saltpetre is dissolved in this mother-liquor to which sufficient water or washings are added to keep up the volume. The main supply of crude nitre is obtained by purchase from small manufacturers. A well near the centre of the yard supplies sufficient water,

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usually of a saline character for the operations. When crude nitre is dissolved in *tor* or mother-liquor and the solution is concentrated by boiling in the large evaporating pans, a dirty white granular substance known as *silta* falls to the bottom of the pan. The *silta* as it forms is removed by means of a large iron spade fixed to a handle 6 feet long. The *silta* thus obtained is sometimes washed and the washings are returned to the pan. In Behar, where *silta* is not excised, it is mixed with the refinery earth. About 2½ maunds of *silta* is separated from each pan of liquor. At a factory near Cawnpore the proportion of *silta* was said to be 20 per cent of the crude saltpetre. Refining of saltpetre. Sitta.

The evaporation of the liquid in the pan is continued at the temperature of boiling water. In some factories the froth or scum, called *zag*, *zoga*, *mail* or *phain*, is removed from the surface at this stage, in others it is removed after transfer to the settling tank. After boiling for three hours, or until the liquid changes from a dark to a light yellow colour, the concentration is considered complete. The liquid is emptied out of the pan by means of an iron scoop known as a *dal* hung at four corners by ropes. Two men stand on opposite sides each holding two ropes. They deftly raise the liquid in the *dal* from the pan and pour it into the wooden trough which leads it to the settling tank. Here the hot liquid is allowed to settle for about 2 hours The scum or *zag* is taken off with an iron perforated *jhara*, and the clarified liquor is decanted, or syphoned off with a bent brass tube, into one or more crystallising vats. At the bottom of the settling tanks is found a substance called *mattaree*, which is a by-product containing nitrates, and is accordingly carried off and mixed with the nitrous earth in the factory yard. The crystallising vats under the sheds are filled with nitre liquor to about 6 inches from the top. In the United Provinces on the surface of each is floated a trellis work made of interlaced bamboo sticks (called *tattis* in Cawnpore). This device facilitates the formation of good crystals. After seven days the bamboo frames are removed and the adhering nitre crystals are shaken or picked off, and the crystals at the bottom and sides of the trough collected into a heap and drained. At Kheora, Cawnpore, troughs of two sizes are used. There are some 3 by 5 feet, which require the liquor to remain eight days, and others, 6 feet square, where the liquor remained ten days. The larger the vessels and the longer the liquor stands, the larger and longer are said to be the crystals. Scum. Crystallising.

The damp saltpetre is contaminated with the mother-liquor adhering to it, and minute crystals of salt, and these must be removed by washing before the salt is ready for the market. Plain water is

Refining of saltpetre

used for this purpose. Alum is occasionally used for the same purpose as indigo blue to whiten the saltpetre. Alum is also used in admixture with saturated nitrous liquor before it is run into the crystallising vats, in order to precipitate matter in suspension in the liquid. Bags containing the refined substance are placed over an empty tub or vat which is slightly tilted to allow the liquor to drain. Cold water is sprinkled from time to time upon the saltpetre through the open mouth of each bag. This water trickles slowly through the saltpetre crystals carrying with it inferior salts in solution. Some saltpetre is also dissolved but the loss is not great. After the washing the refined saltpetre is spread out and dried, and after remaining a few hours is conveyed to the store godown.

Tor

The mother-liquor or *tor* from the crystallising vats and all washings of the refined saltpetre, and of the settling and setting vats and of *silla* are returned to the evaporating pans and used for dissolving fresh crude nitre. It is thus seen that the utmost economy is practised at every stage of the refining processes, and, practically speaking, no nitrate is wasted.

One evaporating pan is capable of dealing with two boilings (40 maunds of crude nitre) per day. The boiling begins early in the morning and is finished by midday. It is calculated that one maund of crude nitre according to its quality will yield from 15 to 23 seers (37·5 to 57·5 per cent.) of refined nitre.

Fuel.

The fuel used at Hansi is cotton stalks, and costs R1 per day. At other factories other cheap fuel, such as dried castor stalks and wild shrubs, is used.

The total output from the refinery described is 2,800 to 3,000 maunds in a season, but the output from any refinery will vary with the quality of the crude nitre. The list of analyses indicates that the quality is very variable.

Government regulations.

A Government license costing R50 is required. The owner is required to keep regular records of all production and purchases of crude saltpetre, the quantity of refined saltpetre produced, and of the *silla* and salt, and details of issues. He is also required to submit weekly returns to the Assistant Commissioner of Northern India Salt Revenue. Officers of the Salt Department visit these refineries whenever they wish in order to check the records, inspect the premises, and see to the removal under the rules and on payment of duty of any salt or *silla* the owner may desire to excise for sale or to the destruction of any salt or *silla* the owner may apply to have destroyed. *Silla* contains a large proportion of common salt, and if removed for sale the nitre refiner is compelled to pay a tax of R1 a maund.

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STATEMENT III.—*Analyses of refined saltpetre.*

Serial No.	Source of Sample.	Register No of sample in the office of the Agricultural Chemist to the Government of India.	Water	Potassium Nitrate.	Sodium Chloride.	Sodium Sulphate.	Calcium Nitrate.	Nitrogen in Nitrates.	REMARKS.
			Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.	
1	Jajmou, Cawnpore, *kalams*	388	1·50	97·37	1·13	...	tr.	13·44	
2	" " unwashed	385	3·23	92·83	3·97	...	tr.	12·69	Ordinary samples of refined saltpetre.
3	Kheora (1), Cawnpore	393	·30	91·34	7·52	·84	tr.	12·60	
4	" (2), "	399	·10	93·74	5·68	·48	tr.	12·93	
5	Hissar, Hansi, Panjab	437	·70	94·92	3·40	·48	tr.	13·09	
6	Siripur, Saran, No. 1	548	1·60	90·16	7·64	·60	tr.	12·44	
7	Dindialpur, Saran, refined	657	3·90	82·68	10·58	1·68	·66	11·52	
8	Sewan, Saran, *kuthia*, refined	931	4·60	89·80	4·64	·96	.	12·37	
9	Bans Deeh, *kuthia*	688	4·20	90·16	3·92	tr.	1·72	12·73	
10	Okara, Montgomery, Panjab	723	3·70	92·68	2·90	·72	...	12·78	
11	Barhanpura, Bihar, refined	770	5·30	90·64	4·06	..	...	12·50	
12	" " washed	771	4·10	94·16	1·74	..	...	12·99	
13	Shahzadpur, Allahabad, R6	711	4·80	93·46	1·74	..	...	12·89	Samples of ordinary refined saltpetre and *kuthia* saltpetre, with market rates for each sample.
14	Bidakhar, Hamirpur, R5	704	2·60	89·86	7·54	...	...	12·40	
15	Lalganj, Saran, R5-8	754	3·10	92·00	1·74	...	...	12·69	
16	" " *kuthia*, R4	755	4·30	74·42	16·24	3·16	...	11·76	
17	Barhanpura, Bihar, *kuthia*, R4	768	4·70	74·96	19·14	2·40	2·64	10·34	
18	Dindialpur, Saran, *kuthia*	656	2·80	74·08	19·40	1·20	...	10·55	*Kuthia* saltpetre.
19	Sewan, Saran, *kuthia*	930	3·80	75·90	18·56	1·96	1·74	10·47	
20	" " washed, *kuthia*	932	2·10	91·02	5·22	1·68	...	12·56	
21	Gorakhpur, *kuthia*	687	4·70	85·50	7·84	·96	...	12·12	
22	Cawnpore Farm	350	7·70	83·09	8·42	tr.	1·96	10·51	Samples used as manure at the Cawnpore and Nagpur Farms.
23	" "	908	2·60	77·24	18·56	·79	...	10·95	
24	Nagpur Farm, R4-8	441	·10	84·25	11·36	tr.	1·60	11·75	
25	Siripur, Saran, No. 2	549	1·60	65·22	32·34	·85	·82	9·00	Adulterated sample.

Composition of refined saltpetre.

The Composition of Refined Saltpetre.

In Statement III the analyses of twenty-five samples of refined saltpetre are arranged in five groups. The reason for grouping is indicated by the headings. Refined saltpetre is called by the manufacturers *kalami shora*, and the analysis shows that the native refiner in this country with his ordinary arrangements can turn out refined saltpetre practically pure. The first sample on the list was perhaps extra carefully refined. The second analysis is of crystals from the same batch which were dried without washing.

The impurities present in refined saltpetre are chlorides and sulphates of potassium and sodium, moisture and insoluble substances.

The first twelve analyses on the list show that samples which are refined in a reliable way are generally of fairly high standard of quality.

The market rates are given for the next five samples on the list, and these indicate that the relation between quality and actual value is fairly recognised in the case of refined saltpetre

Kuthia saltpetre.

The two last samples of this group and the four samples of the next group are called by refiners *kuthia* saltpetre. The term is derived from filters which in Bihar are called *kohs*. This is a white salt which crystallises with a large proportion of chlorides varying in the samples from 7·8 to 19·14 per cent. It is made by evaporating nitrous brine obtained from filtering the refinery earth. *Tor* or mother-liquor is sometimes added.

The samples of the next group were used as manure at the Cawnpore and Nagpur Farms. They are more akin to very good samples of crude nitre than to refined nitre. The Nagpur sample costs R4-8 per maund at Cawnpore and R6 per maund landed at Nagpur, and is not dear at the price. The last sample on the list has obviously been adulterated. It should be noticed that the samples used as manure this year at the Dumraon, Siripur, and Burdwan Farms were distinctly crude and very dear, which proves that buying in the bazar is more or less a lottery.

Saltpetre for gunpowder.

When required for the manufacture of gunpowder saltpetre must possess a high degree of purity. At the Ishapur Factory where until within the last two years gunpowder has been made for Indian consumption, saltpetre "grough" is purchased from Bihar and further refined at the powder factory until a crystal of saltpetre will dissolve in a solution of silver nitrate without producing a cloudiness. A sample of the "grough" bought by the Superintendent, afforded the following analysis:—Insoluble ·08, water 1·97, sodium chloride ·69.

sulphate potassium ·04, or a refraction of 2·78 per cent., leaving 97·22 per cent. of potassium nitrate. Composition of refined saltpetre.

An advertisement recently appearing in the *Government of India Gazette*, for a tender of 10,000 cwts. of saltpetre for use in the cordite factory at Wellington, specified the following limitation of impurities:—"It must contain not less than 95 per cent. potassium nitrate and not more than 0·85 per cent. of chlorides, calculated as sodium chloride determined by analysis of the dried saltpetre." 9th July 1902

Having now shown the nature of the impurities naturally associated with saltpetre, and after discussing the method of their removal, it only remains to give the ultimate composition. The chemical formula of saltpetre is KNO_3, and in the absolutely pure salt the elements are combined in the following proportion:—

Potassium 38·62, Nitrogen 13 86, Oxygen 47·52 = 100 00

The price of refined nitre was last season R5-8 to R6 per maund in Bihar and Hissar, and R8 in Cawnpore, and that of extra good quality with large crystals R9 at Cawnpore.

Sitta and Common Salt.

Sitta.

The Inspector General of Agriculture caused particulars to be collected regarding the use and trade in the common salt educed in the saltpetre refineries. Sodium chloride is a constant ingredient in nitrous earth, and constitutes the chief impurity of crude saltpetre. During the concentration of the nitrous liquor by boiling, it is thrown out of solution in considerable quantity and is afterwards easily divested of its impurities The cause of this deposition is owing to the difference in the solubility of the two salts with the rise of temperature. A quantity of nitrous mother-liquor, saturated in its cold state with saltpetre and chloride of sodium, is placed in a boiler and heated to the boiling point, a little water having been added to it to maintain it in full quantity while being heated. Crude saltpetre is then thrown into it, the nitrate of potassium is taken up in the liquid in solution, and the chloride of sodium with other impurities remains undissolved at the bottom of the boiler and is removed. This undissolved matter is true *sitta*. It is composed for the greater part of common salt mixed with other salts, earth and nitrogenous matter. A similar substance is produced when crude saltpetre is dissolved in mother-liquor diluted by the mixture of nitrous brine from the refinery filters. In such case the chloride of sodium is all dissolved, but is again precipitated when the solution is concentrated to the saturation point of saltpetre. Removed in admixture with earthy and other impurities this impure salt is very

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Sitta. like true *silla* and is classed as such, impure and inedible saltpetre salt.

In the tabulated analyses of fourteen samples of *silla* from the *Panjab, United Provinces, and Bengal, the percentage of alkaline* chlorides varies between 26·68 and 72·5. The sample (No. 486) from Hansi, Hissar, was collected from the drain in the factory where it had been destroyed by mixing with earth and water. The saline matter was recovered in the laboratory at Dehra Dun and afterwards analysed. The separated salt contained 85·2 per cent. of pure sodium chloride with small amounts of sulphates and nitrates.

A tax of R1 a maund is paid for excising silla from refineries in the Panjab, and in the Agra and Farukhabad circles of the United Provinces. The fee was raised from 8 annas to R1-0-0 with effect from 1st July 1901, as there was some reason for supposing that the concession was being abused. In Hansi it is said the selling price is so little above the tax paid for it that it is not worth keeping for sale, hence it is destroyed. In other places *silla* is occasionally sold

Uses of sitta. *for preserving hides and dressing leather. It is also used for pre-* serving coarse beef intended for export to Burma. But in most factories where impure salt is separated it is never sold to the public but is converted into alimentary salt

Edible salt. To educe edible salt crude saltpetre is thrown *into* a *liquid* sufficiently poor in saline matter to take up all of the salts in solution. When the concentration of the liquid approaches the precipitation point of salt, it is removed to a settling vat and impurities in suspension are allowed to subside. It is finally put back into the boiler and further concentrated until salt precipitates and can be removed. The purification of *silla* (impure salt) is generally effected by dissolving it in nitrous brine. The solution is clarified by sedimentation in the settling vat, the clear liquor is returned to the boiler, *lor* or mother-liquor is added, and salt is educed by concentrating the mixture.

A Government tax of R1-8 has to be paid by the refiner for each maund of common salt made in his factory, and it is sold at the rate of R1-9 to R1-12 per maund.

A table of analyses, Statement IV, is appended showing the composition of *silla*. The following table, Statement V, gives the analyses of fourteen samples of *silla* made by Dr. J. Walter Leather, Agricultural Chemist to the Government of India. It will be noticed *that in some instances a large proportion of the chloride exists as a* potassium salt.

STATEMENT IV.—*Analyses of Impure Salt (Sitta).*

Register No. of sample in the office of the Agricultural Chemist to the Government of India.	Source of Sample.	Moisture.	Alkaline Chlorides.	Sodium Sulphate.	Nitrates and other salts.	Insoluble.
386	Jajmou, Cawnpore .	2·80	71·00	6·40	13·60	6·20
391	Kheora (1), Cawnpore .	5·40	58·50	4·93	29·07	2·10
397	„ (2), „ .	1·90	57·93	7·61	18·66	13·90
428	Etah	7·20	51·12	11·44	27·54	2·80
453	Muttra . . .	7·60	64·68	7·92	17·70	12·20
486	Hansi, Hissar .	3·30	85·20	4·66	6·84	...
666	Hardoi, R1-2 . .	5·70	59·92	3·41	26·77	4·20
670	Farrukhabad, R1-2 .	2·80	70·00	5·56	17·04	4·60
21	Okara, Panjab . .	7·00	72·50	3·64	14·76	2·10
731	Bhawani, Panjab . .	6·10	59·16	19·24	13·90	2·60
739	Sirsa, Hissar, Panjab .	7·60	49·88	16·80	21·12	4·60
746	Shahpur, Panjab . .	6·20	70·68	4·12	16·50	2·50
757	Lalganj, Saran . .	9·40	30·16	18·76	29·08	12·60
773	Ramchandarpur, Muzaffarpur.	7·80	26·68	38·24	19·38	7·90

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STATEMENT V.

	1318-04	1319-04	1320-04	1321-04	1322-04	[illegible]	[illegible] 04	1325-04	1326-04	1327-04	1328-04	1329-04	1330-04	1331-04
	1	2	3	4	5	[illegible]	[illegible]	8	9	10	11	12	13	14
	Sitta—Impure salt by-product of a saltpetre refinery—Sikandra Rao, Aligarh District.	Sitta—Impure salt by-product of a saltpetre refinery—Farukhabad.	Sitta—Impure salt by-product of a saltpetre refinery—Farukhabad (*Note I*).	Sitta—Impure salt by-product of a saltpetre refinery—Muttra.	Sitta—Impure salt by-product of a saltpetre refinery—Produced at Sirsa-Hissar.	[illegible]	[illegible] Okarar, Montgomery.	Sitta—About 80 per cent. sodic chloride Impure salt by-product of a saltpetre refinery Farukhabad.	Sitta—About 80 per cent sodic chloride, Impure salt by-product of a saltpetre refinery—Ghatia-ghat Farukhabad.	Sitta—Produced at Laldarwaza refinery—Farukhabad.	Sitta—About 80 per cent. sodic chloride. Impure salt by-product of a saltpetre refinery Bakra-mow, Farukhabad.	Sitta—Monghyr Circle.	Sitta—Patna Circle.	Sitta—Saran Circle.
Potassium Nitrate	10·78	14·49	13·01	14·90	13·78	[illegible]	[illegible]	4·84	11·16	12·39	6·70	14·22	8·20	4·35
" Sulphate	6·70	8·72	8·03	3·68	11·09	[illegible]	[illegible]	5·96	8·98	7·03	6·90	21·40	21·10	6·46
" Chloride	28·27	19·90	9·06	22·97	3·40		[illegible]	...	23·88	24·42	26·11	...	...	...
Sodium Sulphate	...	...	...	...	...	.		5·60	.	...	...	2·62	5·14	6·64
" Chloride	43·01	42·08	58·85	35·80	60·24	40·17	77·70	74·33	39·14	43·20	46·75	36·71	44·52	42·56
Water	6·70	10·64	7·63	15·72	3·42	8·22	·33	5·98	11·54	9·07	9·86	10·84	6·31	6·38
Organic matter	·34	·02	·11	·18	·34	·64	·31	·21	·39	·18	·21	·87	·70	·96
Sand	3·15	1·54	2·34	5·29	6·10	13·39	8·15	·95	1·95	2·66	2·04	12·06	13·16	31·29

Note I—This is more saline than the ordinary "*Sitta*" produced in the Farukhabad Refineries.

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Saltpetre salt.

In Statement VI the analyses of twenty samples of refinery or saltpetre salt are shown. The samples were obtained from Northern India and Bihar. The percentage of chloride varies from 69·44 per cent. in an illicit sample from Sewan to 97·2 per cent. in a sample obtained from Montgomery, Panjab. More than half the samples contained over 90 per cent. Some of the samples are clean and white, and the crystals are dry and uniform. There is nothing injurious to health in the composition of the best samples. Those containing high percentages of nitre might be viewed, however, with some suspicion for household purposes.

The actual values of certain samples were given by officers of the Salt Department, and the analyses show that the prices vary in accordance with the quality.

STATEMENT VI.—*Analyses of Refinery Salt.*

Register No. of sample in the office of the Agricultural Chemist to the Government of India.	Source of Sample.	Moisture	Alkaline Chlorides.	Sodium Sulphate.	Nitrates and other salts.	Insoluble.
387	Jajmou, Cawnpore .	2·20	93·15	...	4·65	..
392	Kheora (1) ,, .	·70	95 42	1·34	2·54	...
398	,, (2) ,, .	2 80	94·52	2·05	...	...
426	Etah, good quality .	1·80	85·20	3·02	9·93	·70
427	,, inferior ,, . .	2·90	76·11	9·38	11·11	·50
451	Muttra, good quality .	1·10	96 68	1·08	1·14	...
452	,, inferior ,, . .	4·70	78·79	3 52	12 79	·20
652	Sewan, Saran, *kuthia* .	1·40	95·85	·24	3·11	...
653	,, ,, *dhulia* .	1·40	96·43	·48	1·69	...
658	Dindialpur, Saran, *kuthia*	1·00	92·22	1·68	5·10	...
661	Sewan, Saran (Illicit) .	7·20	69·44	8·22	11·44	3·70
867	Hardoi, superior, R2-10.	2 60	92·12	1·68	3·10	·50
665	,, inferior, R2-9 .	3·40	86·24	4·40	5·96	...
668	Farukhabad, superior, R2-14-6.	1·90	95·51	1·95	·64	...
669	Farukhabad, inferior .	5·50	82·88	6·82	3·69	1·10
676	Gurwa, Ghazipur, R2-10—R3.	1·60	04·03	1·21	2·26	·90
724	Okara, Montgomery, Panjab.	2·80	97·20	tr.	tr.	...
756	Lalganj, Saran . .	6 90	75·98	9 00	8·12	...
772	Parsanni, Muzaffarpur .	2·90	89 90	2 64	4·26	·30
774	Mankapur, ,, (Illicit)	2·80	84·10	7·28	4·80	1·40

STATEMENT V.

	1318-04.	1319-04	1320-04.	1321-04	1322-04.	1323-04	1324-04	1325-04	1326-04.	1327-04.	1328-04	1329-04.	1330-04.	1331-04.
	1	2	3	4	5	6	7	8	-	10	11	12	13	14
	Sitta—Impure salt by-product of a saltpetre refinery—Sikandra Rao, Aligarh District.	Sitta—Impure salt by-product of a saltpetre refinery—Farukhabad.	Sitta—Impure salt by-product of a saltpetre refinery—Farukhabad (*Note I*).	Sitta—Impure salt by-product of a saltpetre refinery—Muttra.	Sitta—Impure salt by-product of a saltpetre refinery—Produced at Sirsa-Hissar.	Sitta—Impure salt by-product of a saltpetre refinery at Khoie, Ferozepore	Sitta About 80 per cent. chloride of sodium. Impure saltpetre salt by-product of a saltpetre refinery, Okarar, Montgomery.	Sitta—About 80 per cent. sodic chloride Impure salt by-product [illegible]	[illegible]	Sitta—Produced at Laldarwaza refinery—Farukhabad.	Sitta—About 80 per cent. sodic chloride Impure salt by-product of a saltpetre refinery Bakramow, Farukhabad	Sitta—Monghyr Circle.	Sitta—Patna Circle.	Sitta—Saran Circle.
Potassium Nitrate	·10·78	14·49	13·04	14·90	13·78	12·48	2·67	4·	-	12·39	6·70	14·22	8·20	4·35
„ Sulphate	6·70	8·72	8·03	3·68	11·09	24·47	6·71	5·		7·03	6·90	21·40	21·10	6·46
„ Chloride	28·27	19·90	9·06	22·97	3·40		3·11	...		24·42	26·11	...	...	...
Sodium Sulphate	...	...	...	...	...	·78	...	5·		...	...	2·62	5·14	6·64
„ Chloride	43·01	42·08	58·85	35·80	60·24	40·17	77·70	74·		43·20	46·75	36·71	44·52	42·56
Water	6·70	10·64	7·63	15·72	3·42	8·22	·39	5·98	11·54	9·07	9·86	10·84	6·31	6·38
Organic matter	·34	·03	·11	·18	·34	·64	·31	·21	·39	·18	·21	·87	·70	·96
Sand	3·15	1·54	2·34	5·29	6·10	13·39	8·15	·95	1·95	2·66	2·04	12·06	13·16	31·29

Note I—This is more saline than the ordinary "*Sitta*" produced in the Farukhabad Refineries.

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Trade.

In 1859 a duty of 3 per cent *ad valorem* was imposed on the export of saltpetre. This light tax did not affect the trade prejudicially, though there was some rise in price. In 1860-61 an export duty of R2 was levied and this was maintained until 1864-65. This heavy duty was severely felt, and in consequence of its imposition, prices rose considerably, and the trade declined. In 1865-66 the duty was reduced to one rupee per maund, and this was followed next year by a reversion to the 3 per cent. *ad valorem* rate. In the following year (1867-68) the duty was entirely removed, but the trade was unable to recover from the effects of the high rate of duty levied during the six years from 1860-61 to 1865-66 The failure of the trade to recover its former position was probably due to the fact that the high prices imparted a stimulus to scientific enquiry for substances which might supersede the use of natural saltpetre, and this led to the production of saltpetre artificially from the decomposition of sodium nitrate and potassium chloride. Again the manufacture of high explosives such as cordite has largely tended to depress the use of black powder in warfare, sport and blasting.

Effect of duty.

Artificial saltpetre.

Under these circumstances the Indian saltpetre trade has held its own better than might have been expected. There has been a decline in the export during the past few years, but the trade is subject to fluctuations and a revival is possible at any time. The Director General of Statistics in 1902 pointed out that the Indian market is affected favourably or unfavourably by the fluctuations in the artificial saltpetre trade to which it responds. If the competition of artificial saltpetre did not exist, the Indian trade would be steady and progressive despite the excise system. It has been remarked that the Indian trade has been depressed within recent years owing to the increased use in the United Kingdom and America of bone manure which seems to be taking the place there of nitrous manures. But this explanation is not conclusive.

In the Far East the exports of Indian saltpetre to China have grown steadily up during the same period. In Japan, however, owing to cheap freight and the fact that German artificial saltpetre is admitted at half the rate of duty than the Indian commodity has to pay, the exports from India during the quinquennial period 1896-97—1900-01 have fallen from 246 to 61 tons.

The total exports of saltpetre from British India during the five years ending with 1900-01 amounted to 2,055,267 cwt., while the registered production for the same period in Northern India and Madras was 2,046,899 cwt. (2,786,058 maunds). Even allowing for

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By-products.

Other By-Products.

Except *silta*, and the common salt made from it, the by-products of the refinery are not of very great importance. The scum which forms on the surface of the boiling nitre liquor is called by various names, such as *zag*, *zoga*, *mail*, and *phain*. Samples of this product from Kheora and Hansi have been examined, and they have been found to consist chemically of potassium, magnesium and calcium salts, combined as chloride, sulphate and nitrate. These salts were combined with organic matter derived from vegetable débris; the scum is a mixture of crystalline salts and vegetable or organic remains. It contains nitrates mostly of calcium and magnesium.

The two samples were composed as follows:—

	Kheora.	Hansi.
Water	3·90	5·40
Loss on ignition	20·85	22·10
Sodium chloride	51·97	35·28
Sodium sulphate	4·57	3·29
Nitrates of potassium, calcium and magnesium	18·71	33·93
	100·00	100·00

Mattiaree. *Mattiaree* is the Hansi name of the deposit left at the bottom of the settling tank when the nitre liquor has been decanted into the crystallising vats. This consists for the most part of sulphate of calcium, chloride and nitrate of potassium, calcium and magnesium.

Mattiar. *Mattiar* in Bihar is the name of the residual nitrous earth left after the process of leaching.

Trade.

Trade.

As regards the trade in saltpetre, the subjoined tabulated statement of quinquennial averages compiled by the Commissioner, Northern India Salt Revenue, shows what the exports from India have been during the past 50 years

	Average annual export, cwt.	Average value per cwt. R	a.	p.
1853-54—1857-58	606,624	7	14	1
1858-59—1862-63	631,281	10	17	7
1863-64—1867-68	417,895	11	8	3
1868-69—1872-73	464,253	8	15	4
1873-74—1877-78	454,965	9	2	2
1878-79—1882-83	399,839	9	10	7
1883-84—1887-88	425,945	9	6	2
1888-89—1892-93	815,107	9	9	11
1893-94—1897-98	408,585	11	0	8
1898-99—1902-03	374,810	9	15	0

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The total exports of saltpetre from British India during the five years ending with 1900-01 amounted to 2,055,267 cwt., while the registered production for the same period in Northern India and Madras was 2,046,899 cwt. (2,786,058 maunds). Even allowing for

stocks held previously and for errors in registration it would appear that the demand for saltpetre in the country is comparatively small, and that the industry is regulated almost entirely by the requirements of foreign trade.

Saltpetre manufacturers.

List of Leading Manufacturers of Refined Saltpetre in the Panjab, the United Provinces, and Bihar.

1. Behari Lal, Mohalla Lal Darwaza, Post Office Farukhabad, District Farukhabad (United Provinces).
2. Bolaki Das, Mohalla Wrightganj, Post Office Farukhabad, District Farukhabad (United Provinces)
3. Pirag Das, Mohalla Bakramow, Post Office Farukhabad, District Farukhabad (United Provinces).
4. *Gopi Nath Badri Das, Mohalla Ghatiaghat, Post Office Farukhabad*, District Farukhabad (United Provinces).
5. Gokal Chand, Mohalla Khanpur, Post Office Farukhabad, District Farukhabad (United Provinces).
6. Gurmuk Rai Durga Pershad, Village Jajmou, Post Office Cawnpore, District Cawnpore.
7. Baigu Lal, Village Raipur, Post Office Akbarpur, District Cawnpore (United Provinces).
8. Sham Lal, Village Hardoi, District Hardoi (United Provinces).
9. Chotey Lal, Village and Post Office Khyrabad, District Sitapur (United Provinces).
10. Bhai Lall, Village and Post Office Seramow, District Shahjahanpur (United Provinces).
11. *Sheo Narain, Village and Post Office Sirsa, District Hissar* (Panjab).
12. Ramji Das, Village Khaie, Post Office Ferozpore, District Ferozpore (Panjab).
13. D. McLeod, Village and Post Office Okara, District Montgomery, (Panjab).
14. Ramnarain, Village Sohagpur, Post Office Hathwa, District Saran (Bihar)
15. Lachmi Pershad, Village Dataganj, Post Office Chapra, District Saran (Bihar).
16. Saligram Mehto, Village Devaria, Post Office Enai, District Saran (Bihar).
17. Sheikh Mehbcob Raza, Village Savan, Post Office Savan, District Saran (Bihar).
18. Khoob Lal, Village Bhatolia, Post Office Paroo, District Muzaffarpur (Bihar).
19. Raikharam, Village Karnawl, Post Office Sahibganj, District Muzaffarpur (Bihar).
20. Bhondoolal, Village Raini, Post Office Sakra, District Muzaffarpur (Bihar).

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21. Musst. Bholia, Village Surmastpur, Post Office Chandanputti, District Muzaffarpur (Bihar).
22. Gokhal Sahu, Village Surmastpur, Post Office Chandanputti, District Muzaffarpur (Bihar).
23. Beharilal Sahu, Village Pursal, Post Office Katra, District Muzaffarpur (Bihar).
24. Kewalput Sahu, Village Pursal, Post Office Katra, District Muzaffarpur (Bihar).
25. Narain Sahu, Village Bundhu Patti, Post Office Kamtoul, District Darbhanga (Bihar).
26. Ram Lal, Village Bundhu Patti, Post Office Kamtoul, District Darbhanga (Bihar).
27. Doma, Village Gobindpur Behta, Post Office Darbhanga, District Darbhanga (Bihar).
28. Dwarka Pershad, Village Mow, Post Office Mow Bazidpur, District Darbhanga (Bihar).
29. Laltapershad Jhabbu Lal & Coy. Sekandra Rao, Aligarh.

Saltpetre as a Manure.

Saltpetre as a manure.

Nitrous earth is used as a manure by cultivators in tracts where there is an available local supply. In Bihar cultivators employ it as a fertilizer in poppy cultivations In the United Provinces, cultivators utilize as much as they can obtain for wheat, potatoes and other crops. In the Tinnevelly District of Madras, nitrous earth is employed as a manure for tobacco, millets and garden crops. Dr Leather in three samples of this earth found ·78, 1·05 and 1 78 per cent of potassium nitrate. Many trials of crude saltpetre alone, and in combination with bone-dust and superphosphate, have been made at Government Experimental Farms. At the Cawnpore Farm, twenty years' experiments have shown that saltpetre increases the yield per acre of maize from 740 to 1,020 lbs. and of wheat from 1,270 to 1,710 lbs (see N.-W. P. Bulletin No. 9 of 1900). Similar experiments at the Nagpur Farm have given an increased yield per acre of wheat from 420 to 870 lbs At the *Dumraon* farm, saltpetre has increased the yield of paddy from 950 to 1,440 lbs. per acre, and has given good results for wheat (see *Agricultural Ledger* No. 10 of 1893). The best results have been obtained from twelve years' experiments at the Burdwan Farm, where saltpetre has increased the yield of paddy from 1,480 to 4,350 lbs., giving a profit of Rs. 105 per acre for an outlay of Rs. 9-4 on saltpetre. It has also given excellent results when tried upon jute and sugarcane.* Experiments at Poona and Surat have also shown that saltpetre is a successful manure for rice. Saltpetre has thus almost uniformly proved itself directly valuable as a manure for cereal crops, which was to be expected when the average refined

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Saltpetre as a manure.

material contains about 12 per cent of nitrogen and 43 per cent of potash. With an advance of agricultural methods, there should be a considerable expansion in the use of saltpetre as a fertilizer, but under present conditions its extended use is hampered by its price, the cost of railway freight over long distances and the fact that there is no guarantee as to its purity. Indian saltpetre (potassium nitrate) is more valuable than Chili saltpetre (nitrate of soda) in various industries, so that its price is regulated by the export trade and is independent of agriculture.

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G. I. C. P. O.—No. 1401 R. E. P.—19-9-1905.—2,500—P. M. M.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

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1905—No. 4.

MALLOTUS PHILIPPINENSIS.

(KAMALA.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., M. 71–86.*]

The collection and composition of the dye stuff Kamala, by the Officiating Reporter on Economic Products to the Government of India.

Other DICTIONARY articles that may be consulted:

Flemingia congesta, Vol. III., F. 633–42.

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Introducti[on]

Attention has often been directed to the subject of the red dye produced from the glands of the mature fruit of Mallotus philippinensis, commonly known by the vernacular name of *kamala* Its use in medicine is now almost obsolete, and the drug was omitted from the *British Pharmacopœia* of 1898, but there is still a favourable opinion among Indian dyers on its tinctorial properties. Ten years ago a consignment was forwarded to Messrs. Gehe & Co, of Dresden, to ascertain the commercial value of the dye. It was favourably reported on and resulted in an order for 20 cwts. The gross adulteration to which *kamala* is often subjected is a strong reason for the lack of interest which it has received in the trade. A product indigenous to nearly all parts of India should not be allowed to disappear. At the request of the Inspector-General of Forests *kamala* was included by the Reporter on Economic Products in the programme of collections for the year 1898-99, and specimens and information were called for from the chief divisions.

The present *Agricultural Ledger* embraces the results of the enquiries collected from forest officers in all parts of India, and these are published together with the conclusions of the technical researches of Mr. A. G. Perkin of the Yorkshire College, Leeds.

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Vernacular names.

Mallotus philippinensis, *Muell. Arg.; Fl. Br. Ind., V., 442; Ind. Kew., III., 150.*

THE MONKEY FACE TREE.

Syn.—ROTTLERA TINCTORIA, *Roxb.;* R. AURANTIACA, *Hook. and Arn.;* R. AFFINIS, *Hassk.;* R. MONTANA and MOLLIS, *Wall.,* CROTON PHILIPPINENSIS, *Lamk.;* C. PUNCTATUS, *Retz.;* C. COCCINEUS, *Vahl.;* C. MONTANUS, *Willd;* C. DISTANS, *Wall;* C. CASCARILLOIDES, *Rauesch.*

Vern.—*Kambilá, kamúd, kamalá, kamilá, kamelá, rúin, rúlú, kambhal, wussantha-ganda* (powder), HIND.; *Rori* (LOHARDUGGA); *Dhola sindur* (BIRBHUM); *Sinduri* (DARJEELING); *Kamila, túng* (*kishur* or *késar* = saffron), *kamalá guri* (the dye powder), gundi, *kamalá gundi,* BENG.; *Kumala, súndra gundi, bosonto-gundi,* URIYA; *Rora,* SANTAL; *Gangai, puddum, jaggarú, hibang, jarad,* (also for annatto) *lasson,* ASSAM; *Chinderpang, machugan,* GARO; *Sinduria, safed mallata,* NEPAL; *Puroa, tukla, numboongkor,* LEPCHA; *Baraiburi, sindurpong,* MICHI; *Koku,* GOND; *Reoni, roli, kamela* (BANDA); *Ruinia, Kamela* (BIJNOUR); *Rori* (BUNDELKHAND); *Sindúria, puroahung, rohini, rohni, ruina, sundri, kamela, raini, raweni, sindhari,* U. P.; *Rohni* (OUDH); *Rúen, riúna, roli, rauni, rerú,* KUMAON; *Kaimbil,* KASHMIR; *kamela, kamal, kamila,* or *kambila, kahmla, kámal, kambal, kúmila, reini, reun, rúlya,* PB.; *Kámbaila* (PESHAWAR), PUSHTU; *Rauni, rori, chamar gular, ningur, kamella, sendúr, shendur, kúnkú, sindhur, roru,* or *rori, kamela,* C. P.; *kokhu kuku, sendri, kamela* (MELGHAT) BERARS; *shendri, kapela, kamala, kunkuma, kapil,* BOMB.; *shendri, shindur,* MAR.; *kapilo,* GUZ.; *kapli, kapila, kamela-mavu* (? pod = pollen), *thavittai, kuran gumanjanathi kapila rung, kapilapodi, thiruchúrna maram,* TAM.; *kúnkuma, kapila, vassuntagunda* (powder), *chendra-sinduri, sundra gundi,* TEL.; *Kurku, rangamále, corunga-manje, sarnakasari, hulichellu, kunkuma, kasalay, kesalay, kamela,* KAN.; *Ponnagam* (? CALOPHYLLUM INOPHYLLUM), MALAY; *Tawtee-ceng, tan-thieden, tawthidin, pothidin, thidinhmok* (the dye) BURM.; *Tawthadin,* SHAN; *Hamparandella,* SING; *kapila, kampilla* (the red mealy powder), *rechanaka* (*Punnaga* is incorrectly given in many books as Sanskrit for this plant,—see CALOPHYLLUM INOPHYLLUM), SANS.; *Kinbil* (a word derived from the Sanskrit and now restricted in India to this plant), ARAB.; *Kanbélá,* PERS.

Dr. Buchanan-Hamilton called the tree *corunga munji maram* or "Monkey face tree," because these animals paint their faces red by rubbing them with the fruit.

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of the dye stuff Kamala. (*D. Hooper.*) MALLOTUS philippinensis.

References.—*Roxb. Fl. Ind., Ed., C.B.C., 737; Brandis, For. Fl., 441. Kurz, For. Fl. Burm., II., 381; Beddome, Fl. Sylv. t. 2[illegible]; Gamble Man. Timb., 361; Dals. and Gibs, Bomb. Fl., 23[illegible]; Stewart, Pb. Pl., 197; Grah., Cat. Bomb Pl., 1[illegible]; Mason, Burma and its People, 512, 543, 761; Benth., Fl. Hongk., 307; Hooker, Him. Journ. I., 315; Miquel, Fl. Ind. Bat. Suppl., 454. Rheede, Hort. Mal., V., t. 21, 24; Elliot, Flora Andhrica, 36, 86, 95, 96, 98, 103, 151, 165, 185, 1[illegible], 152; Pharm. Ind., 202; British Pharm., 167; Moodeen Sheriff, Supp. Pharm. Ind., 170; U.C. Dutt, Mat. Med. Hind., 232, 302; Dymock, Mat. Med. W. Ind., 2nd Ed., [illegible]; Flück. and Hanb., Pharmacog., 572-576; Pharmacog. Ind., Vol. III, 296. U.S. Dispens., 15th Ed., 828; Bent. and Trim., Med. Pl., IV, t. 236; Murray, Pl. and Drugs, Sind, 34; Med. Top. Ajm., 142; Irvine, Mat. Med. Pat., 45; Buchanan, [illegible] 204, 211; I[illegible] son, Him. I[illegible] Bomb., 122, [illegible] 301, 336; I[illegible] Tans, Beng., 18-20, Buck, Dyes and Tans, N.-W. P., 31; Liotard, Dyes, 56-58, 89, 90, 125; Wardle, Report on India Dyes, p. 5. Darrah, Note on Cotton in Assam, 33; Aplin, Report on the Shan States, 1887-88; Prof. Hummel, (Special Report in connection with Colonial and Indian Exhib.); Kew Reports, 81, 50; Kew Off. Guide to the Mus of Ec. Bot., 119. For. Admn. Report Chutia-Nagpore, 1885, 34; Bomb Gaz., XI, 25. XV., i., 75; Lamk, Encycl., II., 206. Indian Forester, Vol. III., 24, 204; Vol. IV., [illegible] VIII., 106, 110; IX., 4[illegible], X. [illegible]*

District, 15, 63; Peshawar District, 2; Mysore and Coorg, I, 48, 436; II., 7; III., 22; Hunter, Orissa, II., 179, Ap. VI; Manual of the Cuddapah District, 200; Settlement Report of the Upper Goddvery District, 38; Central Provs. (Raipur Dist.), 76. (Chanda District), Ap. VI., Agri.-Hort. Soc. (Old Series), IV., Pt. I., 210, 211; VI., Pt. I., 27. VIII. Sel., 178; XIII., 314, 353, 390, 391; XIV., 21, (New Series) I., 103; VI, Sel., 20; Honigberger, Thirty-five years in the East, 337.

Habitat.—The major portion of the new information in this revision has been derived from correspondence with the Forest officers in the provinces named.

A small, evergreen tree, found throughout tropical India; along the foot of the Himálaya from Káshmir eastwards (ascending to 5,000 feet); all over Bengal and Burma, Singapore, and the

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MALLOTUS philippinensis.	The collection and composition

Habitat. Andaman Islands; and from Sind southwards to Ceylon. Distributed to China, the Malay Islands, and Australia.

Bengal. *Bengal.*—The tree is fairly abundant in the forests of Puri and Singhboom, but is scarce in other localities. A later report from the Puri Division states the plant occurs in abundance in the southern portions of the district. It grows wild in the forests. The tree attains its greatest perfection in open situations. It flowers and fruits heavily on lands leased to the Khonds, who clear away all other tree growth, and carefully prune the trees every year. On these lands the Khonds raise oil-seeds, Eleusine and Phaseolus. But in the thick forest the trees bear few flowers and fruits. The tree attains a height of about 40 feet with girth of about 4 feet. It flowers in December and fruits in January-February.

Assam. *Assam.*—The tree grows wild on lands in Darrang above flood level containing very little humus. It is not abundant. The *greatest height observed is 40 feet, with 3 feet girth.* Reported to occur in the Jorhât Sub-Division where it is known as Assamese or male *Jarat* in contradistinction to Bengal or female *Jarat* or **Bixa Orellana** (Arnatto). The plant is not uncommon in the Nowgong District, where it is found wild on *basti* or high land.

United Provinces. *United Provinces.*—**Mallotus philippinensis** is found in great quantity throughout the Kumaon, Garhwal, and Ganges Sub-Himalayan Forest Divisions. It is extremely abundant in the districts of Kheri, Bahraich, and Gonda and less so in Pilibhit and Gorakhpur. The tree grows wild, for the most part associated with *Sál* (**Shorea robusta**), where it often forms a dense undergrowth. It prefers a porous well drained soil, and is partial to a large admixture of vegetable mould. In favourable circumstances the tree attains a height of 35 feet and girth of 3 feet. Sowings of the tree at Bahraich by the Forest Department have more than once failed, and it was decided in 1899 not to renew them. The tree coppices most profusely, and is a source of some annoyance in *Sál* forests. The tree is common in the Dun; in a few places, aggregating perhaps 3 square miles, it is concentrated, and may be said to form almost the principal species. It occurs sparsely to very sparsely in the *Sál* forests, and in greater numbers in the smaller Kokat forests. It thrives best in the lower levels, and within reach of water, it does not do well with *Sál*, the shade of which is probably heavy for it. The greatest proportions it attains as a general rule are 4 feet in girth and 30 feet in height. It is also found in the Banda District.

Central Provinces. *Central Provinces.*—The tree is reported not to occur in the Bhandara and Chhindwara Divisions. In the Nagpur Wardha Division only one small tree was found; height 11 feet. In

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the other six divisions, the tree is found in small numbers. The following is an abstract of reports furnished by Forest Divisional Officers. Grows wild but not in any abundance on the banks of rivers and *nalas*. Attains a height of 25 to 30 feet with a girth of 6—7 feet (Balaghat). The tree is not common; grows wild along the banks of big *nalas*. Trees are known as high as 25 to 40 feet with a girth of 4 feet. It flowers and fruits in the cold season (Bilaspur). Very seldom met with in Chanda. It is uncommon in Raipur. It grows in sandy soil and attains a height of 20 feet with a girth of 3 feet. Not found in abundance in Seoni. Occurs in dry soil below the hills. Trees as high as 20 to 25 feet with girth of 2½ feet are met with. Met with here and there throughout the Damoh District, but is nowhere very plentiful. It occurs wild, generally on low-lying ground in the neighbourhood of streams and rivers, where the soil is usually of good quality, often mixed with *kunkur*, and contains a fair amount of moisture. The height of the tree varies from 15 to 25 feet, and its greatest girth is usually 3—4 feet. Old pollarded trees of 8—9 feet in girth are occasionally found. The tree is associated with *Kaljamun* (Eugenia salicifolia) and *Koha* (Terminalia Arjuna). Found in only one place in Narsinghpur on the banks of the Nerbudda River. The trees are far from vigorous. Height attained is from 15 to 25 feet with girth of from 18 to 24 inches. Occurs on fairly level ground consisting of a deep sandy loam.

Ajmer.—The Extra Assistant Conservator of Forests, Ajmer-Merwara, reports that Mallotus philippinensis does not grow in the forests of his division Aj

Panjab.—Found scantily in a few forests near Khanpur, in the Hazara Forest Division. The geatest girth and height it attains to are 2 and 15 feet, respectively. The tree is found throughout the lower hills near Rawalpindi up to about 5,000 feet. It is most plentiful in the Marrgolle Reserve about 12 miles from Rawalpindi. It frequents the cooler aspects and *nalas* The tree is not cultivated. The maximum size it attains is 15 feet high and 3 feet girth Is common along the Rávi River to about 15 miles above Chamba. Grows wild as a large shrub or a small tree. Is most abundant in the dry, low hills, particularly near rivers, and appears to thrive best between 2,000 and 4,000 feet, but is found up to 6,000 feet. Its height has not been observed to exceed 25 feet. Very common in the Nurpur Tehsil of the Kangra District. Grows wild all over the scrub forests and often forms part of the undergrowth on open *chil* forests. One of the commonest species in the Nurpur Forests, it occurs up to an altitude of a little over 2,500 feet. The tree grows in abundance in the Simla District. It is met with Pa

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MALLOTUS hilippinensis. The collection and composition

Panjab. on hilly ground and in gravely black loamy soil. The greatest height and girth observed are 30 feet and 3 feet, respectively.

Bombay. *Bombay.*—In the Southern Circle the tree is found chiefly in the more open jungles of the Belgaum Taluka and Chandgad Mahal. Met with only occasionally in the Khanapur Taluka. The tree is plentiful in places in the south-west portion of the taluka. Met with at altitudes of about 2,000 feet, both on hill sides, and along rocky *nala* beds, which are dry for a greater part of the year. The tree attains a girth of 4 feet with height of 15 to 18 feet. (Belgaum). Found only in the evergreen belt of the Matheran slopes, the upper slopes of the Ghats in the Karjat, Kholapur and Nagotna Ranges, and does not grow in abundance in the district. Met with in a wild state and almost always at or round the heads of ravines The plant does not reach any great size in the Kolaba Division. It is reported not to occur in the forests of the Central Circle of Bombay.

Berar. *Hyderabad Assigned Districts.*—Is fairly common on high plateau in the Melghat Tahsil, but is rare below 2,500 feet elevation in the Ellichpur Division. The tree is a small one, and never exceeds 35 feet in height and 3 feet in girth. It reproduces itself naturally by seed, and is not cultivated. It is found along the Penganga River in the Kinwat Reserve, but not abundantly in the Basim Division. The tree occurs wild in loose soil along banks of *nalas.* Average height and girth 12 feet and 3 feet, respectively.

Madras. *Madras.*—Mallotus philippinensis is found widely distributed in the Gamsur taluk of the Ganjam District, and elsewhere in small groups, or as isolated trees along shady water courses. It is also found on the Ramandrug plateau in Bellary. In Ganjam it is met with in and near the cultivated fields, it being kept as a standard tree over field crops. In Bellary, on the plateau and slopes of the Sondar Hills, loose red soil is most suitable for its growth. Maximum height to which it attains about 40 feet, with girth of about 4 feet. Not abundant. Occurs here and there in the Javadis, *Chitteris, Shevaroys* and *Kollimalai Hills of the Salem District.* On the Chitteri Hills trees measuring 4 feet in girth and 30 feet in height are met with. The tree occurs in abundance in the Doddasampagai and Madiswaran Malai Reserve in North Coimbatore. It grows wild in valleys and hollows where the soil is moist. Trees of 30 feet height and 3 feet girth are known, but the Sholagars report that larger trees exist in the Doddasampagai Reserve. Mallotus philippinensis is believed not to occur elsewhere in the North Coimbatore District. *It is scarcely met* with in some *parts* of the Vellapathy block in the south of the district. It occurs

Madras.

generally in the plains and in black soil, attaining a height of about 30 feet with girth of about 2½ feet.

In Madura Mallotus occurs chiefly at the foot of the hills and is found up to an elevation of 3,500 feet. It is not very abundant and is mixed with such plants as Kydia, Nux-Vomica, Amoora, and Zizyphus. In the higher regions it occurs as a straggler in the deciduous forest, associated with Anogeissus and teak. It is not found in evergreen forest. The largest tree in the hills had a height of 30 feet, bole of 10 feet, and a girth a 33 inch. At the foot of the hills the following dimensions were observed: height 18 feet, bole 5 feet, and girth 24 inches. The tree is not abundant nor yet uncommon throughout Tinnevelly. It is found scattered on the Ghat forests and the Taluks along the Ghats. The tree grows wild in deciduous as well as in evergreen forests of low altitudes. In the latter it flourishes in spots abandoned after cultivation. Average height 20 feet; girth 2 to 2½ feet.

Burma.

Burma.—Kurz remarks that "Mallotus is frequent especially in the dry and low forests, all over Burma from Ava and Chittagong down to Tenasserim and the Andamans, ascending into the hill Eng Forests up to 2,000 feet elevation." The tree is found very sparsely in the Tharrawaddy District. It grows wild in moist forest, but was formerly cultivated to a small extent. Average height 23 feet with girth of 3—4 feet. The tree does not seem to grow in very great abundance. Said not to be so common as it is in Upper Burma. It seems to do best in moist sandy soils. It flowers in the rains and fruits in the cold season. The tree is rarely met with in Prome It grows wild in low moist localities, greatest height 30 feet, girth 4 feet. Mallotus philippinensis is found in the hill forests of Bassein, Myaungmya Division, to a very small extent. It is found chiefly at the foot of the Yoma hills Reported not to be known in the Upper Chhindwin Division. It is common but is not used for the manufacture of dye or any other product in the Myittha Division. Occasionally found growing wild, but no dye is obtained from it, nor is it used for any purpose in Lower Chhindwin. Fairly common, but not abundant in Mu. Grows to a maximum height of 20 feet with a girth of 12 inches. Mallotus philippinensis is found only sparingly and of small size in Yaw Division. It requires [illegible] high mean annual tempera- [illegible] Division except perhaps to [illegible] s fairly well represented in [illegible] to the end of March. Said not to be found in this Division (Minbu).

Burma. The tree is found sparingly throughout the Katha District. It grows wild in most forests and used to be cultivated. Maximum girth about 3 feet. The plant is said to be very scarce in the Ruby Mines Division. It has been found apparently wild on some old deserted paddy land near the town of Momeik, the altitude of which is about 500 feet. The tree does not exceed 25 to 35 feet in height with a trunk of 8 to 10 feet in length and 2½ to 3 feet in girth. The plant is not very plentiful in Pyinmana. It occurs in a wild state, scattered here and there, on the outskirts of villages and on the banks of streams; it is also found on the sites of deserted villages. It attains a height of 30 feet and a maximum girth of 3 feet. The seasons of flowering and fruiting of the *kamala* tree in Burma correspond with those in India.

Preparation.

Preparation of kamala.

The separation of the glands from the dried capsules is a matter of great simplicity, as it involves no skilled labour or special appliances. In the Oudh Circle, United Provinces, the fruit is spread on the ground and dried in the sun and then rubbed between the hands or sifted in a cloth. The berries denuded of their coloured coverings are thrown aside. At Dehra Dun the fruit is collected and dried in the sun and the red glands are rubbed off with the hand on a *pakka* or cement floor, or in a bamboo basket or cloth, and afterwards separated by being passed through a fine sieve. The fruit minus the glands is called *baiba rang* by the *paharis* or hill-men. Dr. Stewart states that the capsules, after being allowed to lie in a heap for a few hours, are rubbed or kneaded with the feet on the ground to remove the powder, the broken capsules being then separated by picking and winnowing. One man will collect a ser of powder in a day. The process necessarily admits of much admixture of dust, but the Bhoksas who prepare it in Kumaon deny that any adulteration takes place, and state that it reaches the market in the plains in a comparatively pure state.

In Berar and certain parts of the Madras Presidency the dried fruits are collected and shaken in a cloth, a bamboo basket, or a gunny bag, and the powder passing through is preserved. In Salem the fruits are rubbed together in a blanket, and the red powder, which is easily removed when dry, is collected and stored. In Coimbatore the dye is removed from the fruits by placing them on a clean floor and gently threshing them with a stick. The residue on the floor is then taken and passed through a sieve covered with a piece of muslin.

Some years ago in the Lahore bazar two kinds were sold, one was in a crude state, and the other had been passed through a coarse

cloth to free it from impurities. It is the second kind which Baden-Powell calls *rulya*, a preparation containing 78 per cent. of colouring matter. Preparation. Rulya.

The work of preparing *kamala*, although not requiring any skill, is laborious and unremunerative. The collecting of it does not affect the prejudices of the higher caste in India, yet the industry is almost entirely in the hands of the more uncivilized tribes. The Khonds in Orissa, the Savaras in Ganjam, the Bhoksas in Oudh, the Chamars in Nurpur in the Panjab, and the Kols in the Central Provinces comprise the chief collectors. Some natives regard the beating of *kamala* fruits and winnowing of the powder as an occupation suitable only for women; in Bilaspur the men refuse to collect it, but permit their women to prepare it whenever there is a demand.

Yield.

Yield.

The amount of *kamala* afforded by a tree depends upon the size of the tree and the maturity of the capsules at the time of collecting. A well-known Conservator of Forests has observed that the fruit of the Bengal plant is much larger than that of the United Provinces, and doubtless yields more abundant and better colouring matter. Some attention to the tree would also benefit the yield, and it is known that the Khonds, who carefully prune the tree each year, secure more produce than other tribes. As noticed in the forest reports, the trees are always found in a wild state, and range in height from 15 to 17 feet to 40 feet, so that a uniformity of yield is not attained. The dye is washed off by the rains, and attrition of the capsules by violent storms, or movements of animals and birds cause a loss

The following calculations were made a few years ago by Forest Officers in three selected districts. In Puri it was found that 70·56 sers of fruits were required to produce 1 ser of powder, this is equivalent to 1·41 per cent. Another experiment showed that 3·68 capsules yield 1 grain of dye. In Dehra Dun it was ascertained that 50 trees gave fruits weighing 7 maunds 23 sers, and produced 9½ sers of *kamala*, which is equal to 3 chittacks per tree, or 2·93 per cent. on the fruits. In the Bahraich Division, United Provinces, 80 sers of fresh fruits or 56 sers of dry fruits gave 2 sers 1 chittack of *kamala*, or 3·67 per cent.

From the Dehra Dun experiment which was undertaken with care, one tree will yield 6 ounces of *kamala* powder. In the Kangra District, where the plant grows freely, the average quantity of dye per tree is said to be 8 ounces. In the Puri Division of Bengal, in Berar, and in Salem the average yield is said to be one pound. An estimate of much over one pound of *kamala* per tree, in the light of Average yield not more than one pound per tree.

M.

Average yield not more than one pound per tree.

this evidence, would be excessive, and the following large yields probably refer to the dried fruits and not the glands. Burma 7 to 14 pounds, Belgaum 12 to 15 pounds, Kollegal 10 pounds, Madras 7 to 8 pounds, United Provinces 3 to 4 pounds. On the other hand, we may take as correct the small yield in districts where the tree is stunted and scarce: Central Circle, Central Provinces, 1 to 1½ *tolas*;* Jubbalpur, "not more than two *tolas* from each tree;" Hazara, Panjab, "only a few *mashas* per tree" (*masha*=15 grains); Bassein, Berar, a "mature tree yields 5 *tolas*;" Prome in Burma, "5 to 10 ticals a tree in one year" (3 to 6 ounces).

Collecting areas.

Collecting areas and trade.

From a study of the distribution of the tree it will be seen that it is grouped or concentrated in about three or four centres where conditions of labour render it practicable to collect *kamala* for the market. The chief locality is in the hilly districts of Orissa and Ganjam, where the dye is collected by a jungle tribe called Khonds, now called Kandhs. The Kandhs are a Mongolo-Dravidian race numbering 612,483 at the census of 1901, and distributed in Madras, Bengal, and Central Provinces. They are a simple folk, and part with the powder to the low country native dealers settled amongst them for a few measures of rice or a yard or two of cloth. The output of the Ganjam-Gumsur forests in the north of the Madras Presidency is from 30,000 to 35,000 pounds, the cost price at Madras, including transport and delivery, is R20 to R40 per 100 lbs. In Ganjam 100 *lbs.* of powder could be delivered at Berhampore railway station or at Gopalpur, a sea-port town, at R12; this includes seignorage, cost of collection and transport. In Bengal, Puri, Singhbhum, and Jalpaiguri are considered the best places for collecting the dye, the tree being scarce elsewhere in the province. The dye was formerly procurable in large quantities from Raman Lall Das, of Elam bazar, Birbhum, at R13 to R14 per maund. Dr. Irvine in 1848 quotes 3 annas a pound (R15 a maund) as the price of *kamala* in the Patna bazar, indicating no fluctuation in value during the past half century.

United Provinces.

In the United Provinces, although extremely abundant in Oudh, it is reported that the dye is no longer used or exported from Northern India. About fifteen to twenty years ago (1878 to 1883) the product was leased out and large exports took place; at the present time we are assured that no collectors of *rohini* berries are found in the forests. In 1882 it was said that 2,000 maunds of dye were exported every year from the Kumaon forest division. The Bhoksas sold the powder to dealears for 5 sers the rupee. Dehra Dun

* 180 grains=1 tola, 5 tolas=1 chittack, 16 chittacks=1 ser (2¼lbs.)

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was formerly known for its *kamala* dye which was sold in the bazar at retail prices varying between 2 and 10 annas per ser. There is now no trade in the dye whether from Government or zamindari forests. One range officer reported that *Chamars* take the dye free from the latter forests, and after sifting it sell it in the Dehra bazar at 3 to 3½ annas per ser or a slightly higher rate. From an enquiry carried out by Mr. R. C. Milward he found the cost of extraction 3 to 6 annas per ser, but the cost of collection and materials for collection in areas where the trees grow thickly was R2½ per ser. At the instance of the North-West Soap Company in 1894, *kamala* powder was collected in the Dehra Dun Division at a cost of R31-8-0 for one maund and 7½ sers. (*Commercial Circular* No. 5 of 1895). It is said that 100 lbs. could be landed at a railway station for R10 to R12. With systematic working, about 1,000 maunds of powder could be produced from the Oudh Circle, but it would take time to arrange for such an output. Trade. In value.

The *kamala* dye trade in the Central Provinces is unimportant In the Southern Circle the dye is imported from Bombay and Cawnpore and sold by local *bunias* in small quantities. There is little local trade at Jubbalpur; small supplies are imported from Cawnpore and Northern India, and sold in the bazar at R12 to R24 per maund. Small quantities are exported to Berar and Nimar for dyeing silk. If a demand were to arise about 100 lbs would cost R20 at the nearest railway station, but only a few maunds per annum could be expected from the jungles, where the Kols, a wild tribe near Sambalpur, prepare the powder. Central Provinces.

Panjab.—The *kamala* tree is very abundant in the Nurpur forests, Kangra, and the dye is easily collected. About 30 maunds are annually exported from Nurpur, where it is sold more or less adulterated at the rate of 4 sers per rupee. The cost of 100 lbs. at Nurpur is R12-8, and this amount delivered at the nearest railway station, Patankot, would be R16. At Amritsar it is said to fetch R20 a maund. *Kamala* is imported into Rawalpindi from the Hosiarpur District at the latter price. The tree grows in abundance in the Simla forests, but the dye is not used. It is seen that the forests of the Punjab would be equal to supplying considerable amounts of *kamala* should there be a revival of the trade in India. Panjab.

The Belgaum District in Bombay is the principal collecting ground for *kamala* in Western India. About 4,000 lbs. are collected and sold locally every year at 4 to 6 annas per pound. Including the yield of neighbouring talukas, the total outturn amounts to 5,000 and 6,000 pounds. The price of 100 pounds delivered at Belgaum railway station is R12-8. It is obtainable in the bazars all the year round. Dr. Dymock states that the average value of the Bombay

Adulteration.

A sample recently submitted to the same treatment yielded 58 per cent of worthless impurities; and

5, 10, 4, 8, 9 and 4 per cent. of purified kamala yielding 40, 35, 24, 21, 14 and 12·5 per cent. of ash.

In 1899 the Reporter on Economic Products forwarded to the Imperial Institute selected samples of kamala received from the North-Western Provinces. The samples were sent through the Director, Professor Dunstan, to Mr. A. G. Perkin, F.R.S.E., of the Dyeing Department, Leeds, whose investigations in the chemistry of the dye have been so valuable. Mr. Perkin's, paper entitled the

Mr. Perkin's paper.

Adulteration of the Indian Dye stuff, Kamala,

is reprinted from the *Journal of the Society of Chemical Industry*, 30 June 1900, No. 6, Vol. XIX.

"Kamala is the red mealy powder found on the surfaces of the trilobed capsules of the Mallotus phillipinensis, and is employed as a yellow dye stuff and for medicinal purposes. Its most important constituent is rottlerin, but in addition it contains insorottlerin, two resins, and a wax.

"Owing to the frequent adulteration which kamala undergoes in India, its examination in this respect was suggested to me by Prof. Dunstan, M.A., F.R.S., of the Imperial Institute, and four selected samples of the dyestuff were forwarded from India for this purpose. An accurate determination of the value of kamala by means of dye trials is not possible, owing to the incomplete exhaustion of the dye bath, and it is therefore necessary to estimate the ash, and more especially the constituents soluble in ether, for to these latter the tinctorial and medicinal effects of the drug are due.

"Anderson (*Edin. New Phil. Journ.* I. 300), who first examined kamala, states that his sample contained 3·49 per cent. of water, 78·19 per cent. of resinous matter, and 3·84 per cent. of ash, whereas Flückiger (*Archiv. der Pharm.* 1892), who examined a special sample from Java, found but 1·363—1·488 per cent. of ash. On the other hand, Seidler and Waage (*Ber Pharm. Ges. I. Berlin.* 1891, 80) found that the best kamala that could be procured by purchase in England, Germany, and North America contained at least 5 per cent. of ash, and frequently more. Instances of adulterated kamala have been previously mentioned (*Journ. Chem. Soc.* 1893, 63, 975), containing 52·5, 56·4, and 46·4 per cent. of ash, and some time ago, the writer received a sample of so-called kamala from Sir Thomas Wardle, of Leek, which consisted entirely of mineral matter.

"That various qualities are on the market is indicated by the following varieties which are offered for sale in a German catalogue,

of the dye stuff Kamala. (*A. G. Perkin*). MALLOTUS philippinensis.

Adulteration.

Mr. Perkin's paper.

viz.:—Kamala pura vera, 5 per cent. ash; Kamala, 3·5 per cent. ash; Kamala bidepurata, 10 per cent. ash; Kamala, 18, 25, and 35 per cent. ash, and kamala naturalis

Analyses of the samples received are given below:—

(*a*) *Dye Powder, pure Bakraich, N.-W. P.*

	Per cent.
Soluble in ether	56·01
Organic soluble in water	7·65
Inorganic soluble in water	3·07
Woody fibre	21·30
Insoluble inorganic	11·90

(*b*) *Dye Powder, pure, freshly collected Gorakpur, N.-W. P.*

	Per cent.
Soluble in ether	51·67
Organic soluble in water	8·11
Inorganic soluble in water	2·51
Woody fibre	19·01
Insoluble inorganic	18·79

(*c*) *Dye Powder, Bazar, ordinary sample, Bahraich, N.-W. P.*

	Per cent.
Soluble in ether	39·16
Organic soluble in water	11·55
Woody fibre	21·84
Inorganic matter	27·45

(*d*) *Dye Powder, locally purchased, Gorakpur, N.-W. P.*

	Per cent.
Soluble in ether	7·71
Organic soluble in water	1·87
Woody fibre	3·42
Inorganic matter	·00

"Samples (*a*) and (*b*), though guaranteed free from adulteration, were evidently inferior in quality to the kamala examined by Anderson and Flückiger (*loc. cit.*). They contained fragments of capsules, seeds, and other vegetable extraneous matters, evidently derived from the Mallotus philippinensis itself. The impurity, being of a coarser nature than the kamala, could be removed to a large extent by sifting (through silk), and that the product was much improved thereby is shown by the following determinations:—

	(*a*)	(*b*)
	Per cent	Per cent.
Ash before sifting	14·97	21·30
Ash after sifting	8·79	12·60
Ash in residue	23·71	30·47

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Adulteration. at eight per cent. For dyeing purposes the powder should not exceed ten per cent. of ash, and anything beyond this amount should be considered unsuitable. For medicinal purposes the powder should be of the utmost purity, and its frequent admixture with foreign matters has probably lowered its reputation in medical circles.

Dyeing.

Dyeing.

The process of dyeing in Belgaum is as follows: 2lbs of silk and 1lb carbonate of soda are placed in a vessel of water and boiled for a short time. As soon as the silk softens it is removed. In the same water are then placed 20 tolas of kamalà powder, 2½ tolas of jinjelli oil, ½lb. of the alum, 1lb. of carbonate of soda (in addition to the 1lb. previously used). This mixture is boiled for quarter of an hour and then the silk is replaced in the vessel and taken out after another quarter of an hour's boiling. The colour is deep yellow.

In India

At Kollegal fullers earth and lime are used to soak the silk before dyeing. The jinjelli oil is added to prevent the liquor from frothing over when boiling.

In Burma the material to be dyed is first washed with water in which ashes have been boiled. This is to remove any grease in the material. The kamala is then added and the material is boiled until it is of the desired tint. When this stage has been reached, a little lime juice and alum are added to fix the dye. This gives a yellow colour. To obtain a red dye, when the above process is finished, the material is soaked in water in which lac has previously been boiled.

In the Yaw Division of Burma the ashes of the plantain tree are employed as a mordant in the dye bath.

Technical experiments in England.

Messrs Hummel and Perkin (*Imperial Institute Journal, March 1897*), find that using a dyebath without addition sodium carbonate, a very feeble yellow was obtained on silk, but on addition of sodium carbonate a full bright orange is readily obtained if the operation be not prolonged; long boiling destroys the rottlerin.

The best results were obtained by adding to boiling water one part of kamala, and half to one part of sodium carbonate, then introducing the fabric and dyeing at the boiling point for from two to five minutes. The bath, of course, is not exhausted by such a rapid dyeing process. Other experiments showed that the proportion of sodium carbonate should be from thirteen to fourteen grains per litre of water. After dyeing for a short time with alkali only, the addition of alum or stannous chloride to the dyebath makes the colour a deeper and fuller orange.

In none of their dyeing experiments were Hummel and Perkin able to obtain the red orange shades of native kamala dyed silk;

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Dyeing.

these, they think, are produced by addition of other dyes, since when spotted with strong sulphuric acid they give a different colouration from that given by fabrics dyed with kamala alone.

Conclusions.

The authors remark that the colours given by kamala on silk are fugitive to light, and since there are many artificial orange and yellow dyes now in use which are as easy of application and give much faster colours, it is out of the question that kamala can become a dye stuff of any value in European commerce.

Chemical results.

In 1895 A. G. Perkin contributed to the Chemical Society the following note on "A Dyeing Property of Rottlerin." "The method of dyeing with kamala is not well understood, and is certainly rather remarkable, for, as previously shown, the various constituents it contains are insoluble in water. It is not intended to enter into the details of the process here, but the method essentially consists in boiling the material (chiefly silk) with kamala suspended in sodium carbonate solution It is probable that in the process rottlerin plays the chief, if not the only, part, and the result obtained is due, not to the fixing of rottlerin on the material, but of the decomposition products produced by the action of the sodium carbonate, one of which, as shown above, is rottlerone Even if the material be previously mordanted, no compound of rottlerin can be fixed in the fibre, because, as already stated, the alumina and iron compounds of rottlerin are decomposed by boiling sodium carbonate solution. Though of no practical value, it appeared interesting to test the behaviour of sodium and potassium rottlerin towards mordanted calico. For this purpose, they were suspended in water, dissolved by the addition of a little alcohol, the mordanted calico entered, and the whole brought to the boil As was expected, the material was found to be dyed, yielding the following somewhat poor shades, iron mordant, brownish-black, alumina, pale orange-red; and mixed alumina and iron, orange-brown."

Other uses of Kamala.

Other uses.

The red powder is said to be used by Hindu peasants in the Central Provinces for decorating their faces In Berar it was formerly used by women of the lower classes in the place of *shendur* to mark their foreheads but other pigments are now applied to this purpose. [illegible] pany to be [illegible] reported [illegible] ther substances the powder yielded only a pale yellow or orange dye and that of a dirty hew which was not permanent

Timber.

Timber.—Gamble remarks "The wood is of little use as timber, but is a useful fuel." The weight of a cubic foot ranges between

MALLOTUS philippinensis. The collection and composition of the dye stuff Kamala.

Timber.

41 and 51 pounds. It is reported to be used for fuel in Assam, Central Provinces (Jubbalpur), Bombay and Tinnevelly. The length of the bole is insufficient to permit of utilisation as squared timber even if desired. Its uses in the United Provinces are for temporary thatched buildings and for axe handles. In the Panjab the timber is known to be eaten by white-ants, and is only used for roofing poles when no other material is available. In Kangra the timber is sometimes used for rafters, and in Coimbatore the posts for house building are sometimes prepared from the tree. The cartmen and bullock-drivers of Kolaba, Bombay, employ *shendri* shoots for their driving sticks. They say that the wood is not too hard, and the sticks do not split up, and they last a long time.

Seeds.

Seeds.—The seeds, of which three are contained in each capsule, are black or dark grey, rounded, and slightly flattened on one side. They are about the size of black pepper. Their resemblance to the fruits of Embelia Ribes has been observed in the Panjab where the confusion of the names—*baobrang* for Mallotus and *bebrang* for Embelia—has existed. In Katha, Burma, the seeds ground to a paste are applied to wounds and *dah* cuts.

Greshoff, in 1898, discovered in the seeds a bitter glucoside soluble in water and alcohol, that may be shaken out of a water extract by chloroform.

The seeds analysed in the Indian Museum afforded:—Moisture, 8·75; fat, 5·85; albuminoids, 16·81; carbohydrates, 47·49; fibre, 17·35; ash, 3·75. They are, therefore, not oil-yielding seeds as has been reported.

Bark.

Bark.—The bark has been reported to be used in the United Provinces for tanning leather. Professor Hummel found 6·5 per cent. of tannin in the dry, powdered bark indicating an inferior material.

During some recent experiments in Rangoon, Burma, the bark of an undetermined species of Mallotus has been found to produce a most satisfactory tanning extract.

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All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

(Vegetable Product Series, No. 92.)

THE

AGRICULTURAL LEDGER.

1905—No. 5.

TARAKTOGENOS KURZII.

(CHAULMUGRA.)

[*DICTIONARY OF ECONOMIC PRODUCTS*, Vol. IV., G. 381-388.]

Chaulmugra seeds of commerce,

by David Hooper, F.C.S., F.L.S.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING,
1906.

THE

AGRICULTURAL LEDGER.

1905 No. 5.

The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these Ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

To facilitate the preparation of an index to THE AGRICULTURAL LEDGER, the following arrangements have been made, commencing with 1900:—

All papers published will be paged, irrespective of subjects, into an annual volume. The annual paging will be given on the top of the pages. But to permit of a continuation of the classification into the various series hitherto observed, a further folio will be shown at the bottom of the pages. This will be preserved throughout each series and be continued for several years, until in fact sufficient material in each series has been accumulated to constitute a fair sized volume.

At the end of the year a printed index and title-page will be issued for the annual volume, and after a period of, say, five years an index and title-page will be issued for each series. It has been found that many persons subscribe for a certain series only and do not care to receive the others. The new arrangement, while permitting of the formation of an annual volume, will at the same time retain the serial classification.

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AGRICULTURAL LEDGER.

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(Vegetable Product Series, No. 92.)

THE

AGRICULTURAL LEDGER.

1905—No. 5.

TARAKTOGENOS KURZII.

(CHAULMUGRA.)

[*Dictionary of Economic Products, Vol. IV*, G. 381-388.]

Chaulmugra seeds of commerce,

by

David Hooper, F.C.S., F.L.S.

Taraktogenos Kurzii, *King, in Journal Asiatic Society Bengal, LIX. Pt. II. (1890), 121.* — TARAKTOGENOS KURZII.

Syn.—HYDNOCARPUS HETEROPHYLLUS, *Kurz.*

Vern.—*Chaulmugra, chaulmoogra*, BENG., HINDI, *Kalaw-bin* (the tree), *kalawthee, kalaw-thi* (the seeds), BURM. *Toung pung*, ARAKANESE.

Habitat.—A large tree 40 to 50 feet high found in the following districts:—EASTERN-BENGAL AND ASSAM. Chittagong, Tippera; South Sylhet; Lushai Hills. BURMA. Arakan Yomas, Mandalay, Pyinmana, Tharawadi, Hanthawady, Shwegyin, Pegu, Amherst, Mergui; and in the Andaman Islands. — Habitat.

History.—It seems that the inhabitants of South-Eastern Asia have for a long time been in the habit of using the seeds of this and of one or more allied species as a remedy for leprosy. Dr. Dymock states that in the *Makhyan-el-Adwiya* there is a short notice of the seeds under the name of *Chawul mungri*, and that their use in leprosy and other skin diseases is mentioned both as an internal and external remedy. Dr William Roxburgh in 1815 defined the origin of the seeds as **Chaulmoogra odorata**, and in 1819 R. Brown described the plant under the name of **Gynocardia odorata**. In the *Bengal Dispensatory* published in 1842, the tree, under the former — THE IDENTIFICATION OF THE BAZAAR SEEDS. — A. D. 1815.

IDENTIFICATION OF THE BAZAAR SEEDS.

name, is said to be a native of Sylhet, and the seeds and oil were employed extensively in the treatment of cutaneous affections. In the *Indian Annals of Medical Science*, April 1856, it was brought to notice as a remedy for secondary syphilis. It was first given as a remedy for phthisis and scrofula by Dr. R. Jones, of Calcutta, in doses of six grains three times a day. In 1868, it was made official in the *Pharmacopœia of India*, where an ointment is directed to be made from the pounded kernels mixed with simple ointment. In that work it is recommended as an alternative tonic in cases of leprosy, scrofula, other skin diseases and rheumatism, in doses of six grains of the powdered seed in pill three times a day, to be gradually increased till nausea is produced, or five or six drops of the oil, similarly increasing the quantity. The oil appears to have been first used experimentally in England in the seventies. Of late years the knowledge and use of the drug have spread to Europe and America, where it appears to be increasing in favour and reputation.

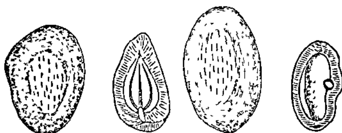
Chaulmugra oil is officially recognised in the Indian and Colonial Addendum to the *British Pharmacopœia*, Government of India edition, 1901.

A. D. 1899

The identification of the true botanical source of the chaulmugra seed of commerce originated with a French pharmacist, M. G. Desprez. During the year 1899 this gentleman made the discovery that the seeds received in Europe did not belong to Gynocardia odorata which for nearly one hundred years had been recognised as the source. This fact was communicated to Lieutenant-Colonel D. Prain, the Director of the Botanical Survey of India, who about the same time had found that the seeds sold in the Calcutta bazars are not those of a Gynocardia. But M. Desprez, not going quite so far in his analysis and still considering them to belong to that genus, provisionally named the source Gynocardia Prainii. Colonel Prain applied to the Reporter on Economic Products for information on the subject, and that officer instituted an enquiry in 1900, in Chittagong, Assam and Burma, requesting botanical specimens of the trees yielding the commercial seeds Numerous samples were received, and in April 1901, Colonel Prain, on being supplied with material, recognised the plant as Taraktogenos *Kurzii*, a species described by Sir George King in 1890. Both trees grow in Chittagong and Sylhet; but while the Gynocardia is found in Sikkim and the Brahmaputra valley in Assam, Taraktogenos is widely distributed in Burma. As Colonel Prain points out the name Chaulmoogra odorata has priority over the name Gynocardia odorata, and is therefore the correct one to give to the tree which is the origin of the false Chaulmugra seeds.

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The inflorescence of the two trees may be easily distinguished. **Taraktogenos** has free sepals, small petals and flowers; **Chaulmoogra odorata** possesses connate sepals in a valvately, toothed or irregularly bursting cup, petals rather large and flowers comparatively conspicuous. DISTINCTION OF TARAKTOGENOS AND CHAULMUGRA.



Taraktogenos (True chaulmugra) — Chaulmoogra odorata.

The above figures illustrate the characters of the seeds. **Taraktogenos Kurzii** seeds have a thick, firm testa; albumen copious, firm; embryo central, straight, with large, cordate, foliaceous, 3-nerved cotyledons, **Chaulmoogra odorata** seeds are obovoid, imbedded in pulp, with large, tough, thick testa; albumen oily, cotyledons large, flat, fleshy, reniform, usually more or less eccentric, with radicle usually horizontal.

A description, with illustrations, of the microscopic structure of Chaulmugra seed, by Dr Joseph Moeller of Vienna, appears in *Pharmaceutical Journal* [series 3] XV. (1884), 321.

Chemical Composition—An exhaustive analysis of the oil was made by Mr. John Moss in 1879, and the result was communicated to the British Pharmaceutical Conference at Sheffield (see *Year-Book of Pharmacy*, 1879, 523-533.) The oil was shown to have a decidedly acid reaction, a melting point of 42° C., and to contain the following constituents: *gynocardic acid 11·7, palmitic acid 63,* hypogæic acid 4, and cocinic acid 2·3 per cent. These acids exist in combination with glycerol (or glycerine) as fats, and the two former in the free state as well. The acrid burning taste of the oil is said to be due to the first mentioned acid, the probable formula of which is $C_{14} H_{24} O_2$, with a melting point of 85° F. (29·5° C). CHEMICAL COMPOSITION. Analysis by Moss.

A proximate analysis of chaulmugra seed was made by E. Heckel and F. Schlagdenhauffen in 1885 (*Journal de Pharmacie et de Chimie*, April 1st, 1885.) The fatty matter soluble in petroleum ether amounted to 30·12 per cent., albuminoids 24·2, and fixed salts 4·93 per cent. By Heckel and Schlagdenhauffen.

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TARAKTOGENOS Kurzii. Chaulmugra seeds of commerce.

CHEMICAL COMPOSITION.

By Petit.

A. Petit of Paris, in 1893, published a process for the preparation of gynocardic acid. (*Journal de Pharmacie et de Chimie*, in *Year-Book of Pharmacy*, 1894, 66). This consisted in saponifying chaulmugra oil with a solution of caustic soda, decomposing the resulting soap with sulphuric acid, and crystallising the fatty acids in 60 per cent. alcohol.

According to A. H. Allen (quoted by T. E. Thorpe, *Dictionary of Applied Chemistry*, iii 43) the fat contains umbellulic acid. This acid is said to occur not only in chaulmugra oil but also in the fat of the Californian Bay tree. The formula for umbellulic acid is C_{14} H_{22} O_2, melting point 28·5, and boiling point under pressure of 100 mm. 212·°5.

Schindelmeiser's analysis.

In 1904 J. Schindelmeiser described chaulmugra oil obtained by cold expression from the seeds as a firm, yellowish mass, throughout which crystalline fatty bodies are distributed. It melted at 26°C., and remained fluid at 20° for about 15 minutes. It is soluble in a large quantity of alcohol and forms turbid solutions with absolute ether, chloroform, tetrachlormethane, carbon bisulphide, petroleum ether and ligroin, small flakes separating from the last two solvents after a short time Its acid number was 25·04, saponification number 232 42, iodine number 92 45. A 35 71 per cent. solution of the oil in petroleum ether showed a rotation of $[\alpha]_D$ 20° + 10°28′. The acetyl number of the fatty acids was 207 8, and the iodine number 110·8. The author's investigations, furthermore, shows that gynocardic acid is a member of the fatty acid series, C_n H_{2n-2} O_2, and that it probably has the formula C_{21} H_{40} O_2 [*Apotheker Zeitung* 19 No. 36 (May 4, 1904), 306].

Power and Gornall's analysis.

The following abstract of a paper* on "The constituents of chaulmugra seeds," by Frederick Belding Power and Frank Howorth Gornall gives the latest and most valuable results of the investigation of these seeds. The authors state that Chaulmugra had previously been examined by Moss (*Year-Book of Pharmacy*, 1879, 523-533), Petit (*Journal de Pharmacie et de Chimie*, 1892, 26, 445), and more recently by Schindelmeiser (*Berichte der deutsche pharmaceutische Gesellschaft* 1904, 14, 164), but their results differ in many respects from those obtained by the present authors, which are as follows :—

An enzyme present.

The seeds of Taraktogenos Kurzii, *King*, contain a hydrolytic enzyme, and also an unstable compound, which reacts with the enzyme, when the seeds are crushed, giving rise to hydrogen cyanide. Numerous attempts were made to isolate this compound but without success. Further experiments will be made in this direction.

* From *Proceedings of the Chemical Society*, Vol. 20, 1904, 135-137.

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On expression, the seeds yielded 30·9 per cent. of a fatty oil, which had the following constants: m. p. 22-23°: sp. gr. 0·951 at 25° and 0·940 at 45°; $(a)^{15°}_{D}$ + 52°; acid value 23·9; saponification value 213; iodine value 103·2. CHEMICAL COMPOSITION.

On hydrolysis, the fatty oil yielded glycerol, a very small amount of phytosterol. $C_{26}H_{43}OH$ (m. p. 132°), and a mixture of fatty acids (m. p. 44-45°; $(a)_D$ +52·6° in chloroform; acid value 215; iodine value 103·2), which consisted chiefly of several homologous acids belonging to a series $C_nH_{2n-4}O_2$ containing a closed ring and ethylenic linking, no member of which has hitherto been isolated from a fatty oil. The highest of these homologues present, which was isolated in a pure condition, separated from most of the usual organic solvents in glistening leaflets (m. p. 68°; b. p. 247—248° 20 mm., $[a]_D$ —59°), has the formula $C_{18}H_{32}O_2$, and is designated chaulmoogric acid. It combines with only two atomic proportions of bromine or iodine. Palmitic acid also was identified, and there is reason for assuming the presence of a near homologue or homologues of chaulmoogric acid, but belonging to the series having the general formula $C_nH_{2n-4}O_2$ with two ethylenic linkings. Undecylic acid and hydroxy-acids were proved to be absent, and, an individual acid corresponding with hypogæic acid could not be isolated. The "Gynocardic acid" of all previous investigators is believed to be a mixture of several substances. Power and Gornall's analysis.

The "press-cake" yielded, besides formic and acetic acids and a very small amount of volatile esters having the characteristic odour of the seeds, an appreciable amount of a neutral oily substance, $C_{18}H_{34}O_2$. (b. p. 214-215°/18 mm., sp. gr., 0·9066 at 16°/16°, $[a]_D$ —42·4°), which is isomeric with chaulmoogric acid; this substance is being further investigated, as are also the seeds of **Gynocardia odorata.** The "press-cake."

A second paper by the above authors deals with the constitution of chaulmoogric acid. The constitution of chaulmoogric acid.

With the object of ultimately determining the constitution of chaulmoogric acid, $C_{18}H_{32}O_2$, a number of its derivatives have been prepared and studied.

Methyl chaulmoograte, $C_{17}H_{31}·CO_2Me$ (m. p. 22°, b p. 227° corr. /20 mm., sp. gr. 0·9119 at 25°/25°, $[a]^{15°}_{D}$ + 50° in chloroform), was prepared by the interaction of the acid, methyl alcohol, and hydrogen chloride. Ethyl chaulmoograte, $C_{17}H_{31}·CO_2Et$, a colourless oil (b. p. 230° corr./20 mm., sp. gr. 0·9079 at 15°/16°, $[a]^{20°}_{D}$ + 50·7°), was prepared in like manner. Chaulmoogramide, $C_{17}H_{31}$·CO-NH_2 (m. p. 106°, $[a]^{17°}_{D}$ +57·30 in chloroform), was obtained according to Aschan's method (*Ber.*, 1898, 31, 2344). Bromodihy-

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CHEMICAL COMPOSITION.

drochaulmoogric acid, $C_{17}H_{32}Br \cdot CO_2H$ (m. p. 36—38°; optically inactive), is formed when chaulmoogric acid is treated with hydrogen bromide in glacial acetic acid.

Ethyl chaulmoograte absorbs two atomic proportions of bromine in the cold, forming ethyl dibromodihydrochaulmoograte, $C_{17}H_{31}Br_2 \cdot CO_2Et$, which is an oil.

When chaulmoogric acid is treated with sodium in boiling amyl alcohol, the ethylenic linking is not resolved, but there were obtained, after fractional distillation of the product, chaulmoogryl alcohol, $C_{18}H_{33} \cdot OH$ (m. p. 36°, $[\alpha]_D$ +58·4°) and chaulmoogryl chaulmoograte, $C_{17}H_{31} \cdot CO_2 \cdot C_{18}H_{33}$ (m p. 42°), together with unchanged chaulmoogric acid.

The saturated acid, dihydrochaulmoogric acid, $C_{17}H_{33} \cdot CO_2H$ (m. p. 71—72°, b. p. 248°/20 mm.; optically inactive), is formed, however, on reducing bromodihydrochaulmoogric acid with zinc dust and alcohol, or chaulmoogric acid with hydriodic acid and phosphorus. By the latter process, a hydrocarbon, chaulmoogrene, $C_{18}H_{34}$ (b. p. 193—194°/20 mm.) is also formed. Methyl dihydrochaulmoograte, $C_{17}H_{33}CO_2Me$ (m. p. 26—27°, b. p. 222—223°/20 mm.), was prepared from the corresponding acid.

Chaulmoogric acid is not attacked by fused caustic alkalis even at 300°.

When chaulmoogric acid was oxidised with cold permanganate (1 atom oxygen), dihydroxydihydrochaulmoogric acid, $C_{17}H_{31}(OH)_2 \cdot CO_2H$ (m p. 102°), was produced, but when the amount of permanganate was equivalent to 4—5 atomic proportions of oxygen, formic acid and two dibasic acids were obtained, the latter having the formulæ $C_{16}H_{28}(CO_2H)_2$ and $C_{15}H_{28}O(CO_2H)_2$ (m. p. 128°). The ethyl esters of these acids were described.

The molecular magnetic rotation of ethyl chaulmoograte very closely approximates to the calculated value for an unsaturated ester of the formula $C_{20}H_{36}O_2$, having a closed ring and one ethylenic linking, the latter being contained in an allyl group. This conclusion, based on the magnetic rotation, is in harmony with the results obtained by the oxidation of the acid.

The further investigation of chaulmoogric acid is proceeding.

COMMERCIAL OILS.

Commercial Samples of the Oil.

Dr. W. Dymock in 1876 (*Pharmaceutical Journal* [series 3], 6, 761) drew attention to the difficulty that was experienced in distinguishing between the genuine oil from mixtures sold by the native druggists. A standard sample of oil was made by cold expression from carefully picked seed. This was of a pale sherry colour, threw

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COMMERCIAL OILS.

down a granular white fat on standing, and the specific gravity was 0·90. A test for the oil was thus utilised. Twenty drops were placed in a watch-glass and one drop of strong sulphuric acid was added; on stirring with a glass rod, a mass of a reddish-brown colour was formed which in the course of a few minutes turned of a rich olive green. Out of five samples tested, only one was genuine, the remaining were supposed to be adulterated with sesame oil, solid fat and nut oil.

It has since been pointed out that the green coloration is not peculiar to the oil but is a property which equally belongs to palm oil

Hirschohn's researches.

Having observed differences in the behaviour of two samples of chaulmugra oil to solvents, Dr. Ed. Hirschohn procured at different times some additional commercial samples and subjected them to comparative examination with three samples prepared direct from the commercial seeds, No. 1, prepared by cold expression; No. 2 expressed warm; No. 3 extracted with petroleum ether. These oils when first prepared were perfectly clear, but in a short time became turbid and granular in consistence. The odour was the same as that of the commercial oils. The yield calculated for the original seed, amounted to 40·25 per cent., and amounted to 62 per cent. of the decorticated seeds used. The melting points of these pure oils varied between 26° and 28° C., while those of the commercial samples designated as A, and C and D ranged from 28° to 30°, the fourth sample B melting, however, at 50° C. The author describes the solubilities of these oils and tabulates the constants, obtained by the usual methods, as follows :—

Sample.	Acid number.	Saponification number.	Iodine number.
No. 1, cold pressed . .	26·84	205·55	99·5
No. 2, warm pressed . .	25·54	210·07	96·8
No. 3, p-ether extract . .	21·14	198·88	98·3
A. commercial oil . .	87·33	253·07	69·7
B. " " . .	34·44	95·60	33·9
C. " " . .	70·66	207·14	88·0
D. " " . .	37·60	198·40	96·4

[*Pharmaceutisches Centralblatt*, 44, No. 38 (Sept. 17, 1903), 627.]

The oil-cake as a manure.

OIL-CAKE.

Last year a Calcutta firm forwarded a sample of chaulmugra oil-cake to the *Reporter* on Economic Products for valuation as a manure. The sample was sent to the Inspector General of Agriculture

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OIL-CAKE.

who obtained the following analysis and report made by Dr. J. Walter Leather, Agricultural Chemist to the Government of India :—

Moisture	7·14
Organic matter	83·42
Soluble ash	7·89
Sand	1·55
	100·00
Nitrogen	3·39
Phosphoric acid	1·80
Potash	1·55

This cake contains half as much nitrogen as good castor cake, and about three-fourths as much as rape and mustard cakes contain. Of phosphoric acid it contains also less than those cakes usually contain and less potash than is often found. In placing a value on this material in comparison with other manure cakes it must be remembered that its nitrogen is very much the most important constituent for most lands. If phosphates were wanted, other materials would be purchased Its market value must also depend very much on the local supply of other materials.

TRADE.

Trade.

Chaulmugra seeds are brought to Calcutta chiefly from Chittagong and as sold in the market are of two kinds, *viz.*, (1) mature seeds with a brown kernel rich in oil; (2) immature seeds with a black kernel, containing a smaller proportion of oil of a dirty colour. The seeds arrive in the market at the end of the rainy season, in November and December. Mr. E. P. Stebbing, Deputy Conservator of Forests, Chittagong, informed the Reporter on Economic Products that chaulmugra seed comes from the Kassalong Reserve in the Chittagong Hill Tracts where it is plentiful; and is exported from the Reserve down the Kassalong river into the Karnafuli river and down the latter to Chittagong. The tree is said to be scarce in the unclassed forests of the Hill Tracts. From 1,200 to 1,500 maunds of seed are annually exported from the Hill Tracts to the collectorate, *viâ* the Karnafuli river alone. About 50 maunds of the seed were exported from the Kassalong Reserve during the year 1899-1900 at R1 per maund. There is no check on the export from the reserved forests of the Hill Tracts, as at present no Government tax is levied on it. The seeds are brought out of the forests by Jumchas and are sold by them to the Bengalis at Kassalong.

Chittagong Forests.

Price.

Chaulmugra seed formerly sold in Calcutta at R5 to R7 per maund of 82¼ pounds. In 1893 the supply in the market was small and the seeds were selling for R13 per maund.

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Occasionally the seeds are sold by public auction in Calcutta. In July 1900, 18 bags were put up for sale, weighing, approximately, 21 maunds. That year the price rose from R12 and R15 to R29 and R30 per maund. The trade is confined to a few Bengali traders, and the quantity disposed of yearly is about 5,000 maunds. Trade.

At present the price of the seed is R3 to R4 per maund at Chittagong and Sylhet, and the Calcutta price R6-9 per maund.

Chaulmugra seeds are collected for sale in Burma, but statistics are not available as to the extent of the exports. In the forest administration reports of ten and eleven years ago Kalawe (Calaway) fruits and leaves are shown to be exported from Mergui to provincial ports.

To extract the oil from chaulmugra seeds the kernels are separated from the shells and dried in the sun. They are then partially pounded with a pestle and mortar such as is used for husking rice and pulses. The broken kernels are then put into canvas pads, and the oil is expressed with the aid of fire in a castor-oil mill. Sometimes the oil is expressed in a native oil-mill, but this method is attended with waste of oil in the refuse. As a rule the oil is not refined. There are two kinds of oil known, *viz.*, (1), clear, bright, straw coloured (2) muddy and precipitating a sediment of earthy colour. Extraction of oil.

One maund of oil is obtained from about four or five maunds of seed. The price of the oil is R60 per maund. Calcutta

Messrs. Butto Kristo Pal & Co. and Messrs. Daw Brothers, Old China Bazar Street, are the principal dealers in Calcutta.

Dr Dymock writing in 1890 in regard to the Bombay trade says, "the seeds come from Calcutta and cost in Bombay about R15 per Bengal maund." The oil has been expressed at the Bombay Medical Store Depôt for many years past and issued for the treatment of leprosy. As the seed obtained locally is not always of good quality, it would appear desirable to obtain a constant supply of good fresh seed from Calcutta. Bombay.

The oil is used in European hospitals in Madras and is chiefly supplied by a contractor who expresses the seeds imported from Calcutta. The rates tendered for the oil at the Medical Stores are 12 annas to R2-4 per lb. Moodeen Sheriff gives its price as R5 per lb. and 6 annas per oz. in the bazars. Madras.

False Chaulmugras.

Chaulmugra odorata, *Roxb.* (Gynocardia odorata, *R. Br.*) FALSE CHAULMUGRAS

A native of Sikkim, Chittagong and Assam. The seeds of this plant have been described (see *ante*, p. 73).

An investigation of these seeds has recently been made by Dr. F. B. Power and Mr. T. H. Lees, [*Journal of the Chemical Society*,

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

(Agricultural Series, No. 37.)

THE

AGRICULTURAL LEDGER.

1905—No. 6.

SORGHUM VULGARE, PERS.,

(ANDROPOGON SORGHUM. BROT.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. VI., Pt., III., S. 2424-2500.*]

SORGHUM VULGARE, PERS., THE GREAT MILLET OR JUAR IN INDIA.

By SIR GEORGE WATT, KT., C.I.E.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1906.

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(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these Ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

To facilitate the preparation of an index to THE AGRICULTURAL LEDGER, the following arrangements have been made, commencing with 1900:—

All papers published will be paged, irrespective of subjects, into an annual volume.

The annual paging will be given on the top of the pages. But to permit of a continuation of the classification into the various series hitherto observed, a further folio will be shown at the bottom of the pages. This will be preserved throughout each series and be continued for several years, until in fact sufficient material in each series has been accumulated to constitute a fair sized volume.

At the end of the year a printed index and title-page will be issued for the annual volume, and after a period of, say, five years an index and title-page will be issued for each series. It has been found that many persons subscribe for a certain series only and do not care to receive the others. The new arrangement, while permitting of the formation of an annual volume, will at the same time retain the serial classification.

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SORGHUM VULGARE, THE GREAT MILLET OR JUAR IN INDIA.

By SIR GEORGE WATT, KT. C.I.E.

SORGHUM HALEPENSE the wild ancestor.

The account may commence with a brief notice of Sorghum halepense, from which the cultivated Sorghum vulgare, is believed to have originated.

Sorghum halepense, *Pers., Synop. I, (1805) p. 101;* HOLCUS HALEPENSIS, *Linn.;* ANDROPOGON HALEPENSIS, *Brot. Fl. Lusit I., (1804) p. 89;* A. SORGHUM, *subspec.* HALEPENSIS, *Hackel in DC. Monog. Phanerog. VI., (1889) p. 501;* ANDROPOGON (SUBGEN. SORGHUM) HALEPENSIS, *Hooker f., Fl. Br. Ind. VII. (1897), 182; Vasey, Agric. Grasses of the United States (1st Ed. 1884), p. 51; 2nd Ed. 1889, p. 36; Duthie, Fodder Grasses N. Ind. (1888), p. 404; Lisboa, List Bombay Grasses (1896), p. 74; Dict. Econ. Prod. VI., Pt. III., 280.* THE JOHNSON GRASS, CUBA GRASS, MEAN'S GRASS, FALSE GUINEA GRASS, EVERGREEN MILLET, ARABIAN MILLET, &c., and in India best known as *Barû, bara, barwa, barua, bowdri, braham, kdld-mucha, galla-jdri, padda-jallagadi, gadi-janu, kartdl, bikhonda, &c.*—names that mostly denote an edible product. A tall perennial grass with strong creeping underground stems which throw up many suckers; common throughout India and Burma on both cultivated and uncultivated lands; indigenous both in India and Africa up to latitudes of 30° North. Some few years ago an effort was made to acclimatise freshly

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SORGHUM HALEPENSE the wild ancestor

imported stock both from Australia and America. As is customary in such experiments it was at first greatly extolled as a valuable addition to the fodder plants (oblivious apparently of the fact that the self-same grass was an abundant wild plant in India), but in time it was condemned, owing to its deep-seated and vigorous root-stocks which were difficult to eradicate. Finally it was recorded that if left to itself the introduced plant was in a few years exterminated by the indigenous vegetation. (*See Experimental Farm Reports:* also *Reports of the Department of Land Records and Agriculture from 1895-96 to 1901-02.*)

There are two forms met with in India which were by Roxburgh treated as separate species but which in the *Flora of British India* are exhibited thus:—

1. Var. GENUINUM, (Andropogon miliaceus, *Roxb.*). Lisboa mentions *narvas* and *bhonda* as vernacular names for this plant. Roxburgh tells us it was sent to him by General Martin who found it on the mountains to the North of Oudh.

2. Var. EFFUSUM, (*A. laxus, Roxb.* (*non Linn.*)); A. halepensis, (*Wight, Cat n. 1672*). According to Roxburgh, this is the plant specially denoted by the names, *kálá-mucha, gadi-janu.* He tells us that it grows in hedges, on banks of water-courses and on land that has lately been cultivated.

In the paragraph devoted below to the history of S. vulgare, reference will be made to the value of this wild plant, admittedly the [illegible] the cultivated [illegible] be suggested [illegible] to be given to S. halepense (in certain mountainous countries) may possibly be intended to denote its somewhat evil reputation. It would appear that the grass eaten by cattle, especially when it is very young or when stunted by drought or parched by growing on exposed dry rocky soils, has frequently poisonous after-effects. Stewart was, for example, told in Hazara that cattle after eating *baru* grass suffered from fatal head affections. In many parts of India it is believed to be injurious until after the rains. The grass, as a fodder plant, is not so highly valued therefore in India as it would appear to be in Australia and United States of America, in which countries it is regularly and extensively cultivated and is never known to become poisonous. It will be seen below that a similar poisonous property is sometimes acquired by the cultivated juar.

The grain is often systematically collected and eaten, though the plant seems nowhere to be specially cultivated. Hamilton, for example, speaks of a kind of bread being made from it in Rajmahal. Tod (*Rajasthan, II., 170*) mentions the seeds being collected and mixed with *bajra* and eaten by the poorer classes in Bikanir.

SORGHUM VULGARE.

S. vulgare, *Pers., Syn. I., 101;* HOLCUS SORGHUM, *Linn. Sp. Pl. 1047;* A. SORGHUM, *Brot., Fl. Lusit. I.* (*1804*), *88; Roxb. Fl. Ind.* (*1832*), *269;* A. SORGHUM, subsp. SATIVUS, *Hack.,* "Ir

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DC. Monogr. Phanerog. vi (*1889*), *505*; *Hooker f., Fl. Br. Ind. VII.*, (*1897*), *183*; *Dict. Econ. Prod. VI., Pt. III.*, (*1893*), *289-317*. THE INDIAN OR GREAT MILLET; GUINEA CORN; TURKISH MILLET; SORGO; KAFFIR CORN; CONGO MILLET; JERUSALEM CORN; BROOM CORN; MILO MAIZE; &c In the vernaculars of India it is the *judr* (*judri*), *jodr, jowdr, juvdr, jvdr, juvri, jundl, jondla, jaundri, jondhala, jonna, janu, jonnalu, jolah, irungu, chola, cholam, talla, tella, konda, rataru, ratadiu, sundia, singhia, jeh, patria, kurbi, challi, chari* (the stalks or fodder), *dhui* (the chaff), *chavela, kasa-jonar, vani, phag, thuthera, lani, ka, kar, kangra, karbi, kadbi* (the stalks), *kutar* (the chaff), *shalu, ganeri, dukria, kadval, sajja, kenjol, yengara, mri garuphongbol, pyaung, &c, &c* NAMES.

In India the Great Millet is sometimes contrasted with Maize and called the *choti-judr* (= small *judr*), just as in Europe in early times it was contrasted with the Roman Zea (Triticum speltum) and in Reunion to-day is the Kaffir Maize Its Persian name *Juar-i-Hindi* points to its having reached that country from India, while its Afghan name (*Jowhri-Turkimani*) points to an interchange with Asia Minor. Though the word *Juar* appears and re-appears, time after time, in the languages and dialects of India cognate with Hindi and Sanskrit, practically every aboriginal tribe or distinctive people has a name of its own for this particular grain, for the plant as distinct from the grain, for the fodder and for the chaff, quite independent of the names given to the corresponding products of wheat, barley, or rice. There are, moreover, distinctive names for each and every one of the numerous cultivated forms of the plant which exist in the provinces of India. In Bombay Presidency alone, over 250 races of the plant are recognised. There are also many curious traditions and religious observances so intimately associated with the grain as to establish beyond cavil a cultivation of vast antiquity. Varieties

Although accepted by most botanists to have been derived from S. halepense, the Sorghum has been dispersed by cultivation to latitudes considerably to the North and South of its indigenous habitat. It is in fact cultivated in most countries between the latitudes of 45° North and 35° South. These are the extreme limits and it does not do well so far North as 45°. In the Trans-Caspian Province of Russia, for example, the roots are apt to be frosted, before the seed ripens. (*cf. "Industries of Russia" (1893), Vol. III., p. 455, trans. Crawford*). In India and Africa it is, however, of greatest value in the upland tracts (above inundation level) between the latitudes of 15° and 30° North. In warmer moister regions, as for example in Bengal, in large portions of Madras, in lower Burma, Limits of Cultivation.

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and in Ceylon it hardly ranks as an important cereal since in these regions the grain ripens but indifferently.

History.—According to Crooke (*Rural and Agric. Gloss. 1888, p 139,* also his edition of *Hobson-Jobson (1903), p. 468*) the word *juár* has been derived from the Sanskrit *yava-parkâra* or *akâra,* which means "of the nature of barley." Dutt (*Mat. Med. Hind., p. 324*) mentions *yâvanâla* and *rakta-khurna* as its special Sanskrit names. From *yâvandla* would, of course, come *jávanála, jauanála, jauandra,* and finally *juár.* The Arabic *Dúra* (or as it is variously written *dhurra, dhaura, douro, etc.*) readily becomes *súra,* and has been sanskritised as *súrna* and is thus but a variant of *júar.* It would seem probable that the earliest mention of the name *dura* (or *dorah*) occurs (9th century A.D.) in Avicenna's reference to the people of Zanzibar living very largely on the grain of that name. As showing the ease with which *juar* has passed into *dura* it may be mentioned that M. Henri Jumelle (*Cult. Colon. 1901, pp. 103-110*) renders the modern Hindustani *juar* as *djowar,* and the Telegu *jola* as *djoula.* The Javanese name for this grain is *djagomutri.* It is probably also the *tsjolam* of the Malabar (*see Rheede, Hort. Mal. XII, 113, t. 60*). It certainly is the *battari* of the Malays (*Rumphius, Herb. Amb. V., 194, t. 75*). According to some writers Sorghum may have been the *dokhan* mentioned in the Old Testament (*Ezekiel, chap IV, verse 9*) though in modern Egyptian that name seems to denote *Setaria italica*—the *Panicum* of Pliny. The *Milium* of Pliny (*Hist lib XVIII, c 7*), which he tells us had been introduced into Italy from India, was doubtless however one of the numerous forms of Sorghum. In Holland's English translation of Pliny (published 1601 A.D.) a marginal note identifies it as "Turkish Millet," thus suggesting an introduction into Europe *viâ* Persia and Asia Minor. Hehn (*Kult-Pfl. Ed. 6, 1894, p. 597, n. 07*) suggests that it does not follow that Pliny's plant actually came from India. The trade route being then *viâ* Alexandria it is probable he thinks that articles procured from Egypt may have come to be regarded as of Indian origin. De Candolle (*Or. Cult. Pl.*) regards Pliny's reference to an Indian Millet as denoting the variety *saccharatum* rather than the *Sorghum vulgare* proper, chiefly because of its being described as 7 feet in height. In India a height of even 12 to 15 feet would be nothing very extraordinary. Rauwolf (*Travels (1583) II. p. 198*) speaking of Babylonia says it was being harvested in October and that it had grown to 6 to 8 cubits in height, though his reference to the stems being chewn, like sugar-cane, suggests the plant having been one of the many forms of the variety *saccharatum.* It is called, he concludes, by its old Arabic name *dora* of which both Rhases and Serapion make special mention. *Forskal (Fl. Ægypt.-Arab. (Niebuhr Ed.) 1775, 174-5)* says its Arabic name is *taam.* Schweinfurth (*Heart of Africa (1873) I., 245-6*) observes that in the Soudan it is called *aish* (= bread). It is the *sergada* in Abyssinia.

Origin of word Sorgh.

The origin of the name Sorghum or Sorgho might be expected to throw much light on the history of the crop. Rees (*Cyclopædia, Ed. 1819*) followed by Paxton, Johnson, and most botanical lexicographers, says it is an

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Oriental word and comes from the Indian *Sorghi*. This doubtless is a mistake since no such name for it exists in any Indian language. Koernicke & Werner (*Handbuch d. Getreide-baues* (*1885*) *I.*, *294-315*) seem to think that it came direct from the Arabic *dorah*. The initial letter they suppose on its passing westward became softened into "th" and ultimately into "s" Sadebeck (*Cult-gew d. deutsch. Kolonien*, (*1899*) *48-52*) and many other authors speak of it as the *sirch* of the Southern Tyrol. He adds that the *sirch*-brooms (often falsely spoken of in trade as rice-brooms) were formerly employed in paying tithes. Wiesner (*Rohst. d. Pfl.-Reiches* (*1903*) *II.*, *207*) calls them "rice-brooms." Most writers on the agriculture of Southern Europe cite names for this plant which may or may not belong to the language used by the authors in question. These are:—*Milium indicum* or *saracenicum* or *sabaeum*, *Turcicum frumentum*, *melica*, *milica*, (Latin); *saggina*, (*saginor* = to swell up), *sorghum*, *sorgi*, *surga*, *melegua*, *sorgho*, &c. (Italian), *cirok*, *sirek*, *sirch*, *sz/érak*, *tatarka*, (Magyar & Slav languages), *blé de Guineé*, *blé barbu*, *sorgho* (*imphy* and *à balais*), *couscou*, *millet-d'Afrique*, *&c.* (French); *boonvana*, *sagova*, *Milium saburrum*, (*sic ?*), (Spain); *Vuelchen* (*Welschen*) *Hirssen*, (N. Germany), *Sorgsamen* (Nuremberg); *Sorg-weizen*, *Supe*, (Upper Tyrol); *Honig-gras*, *&c.*, (Germany); *Turcks-koren*, *sorgsaet* (Flanders and Belgium); *catambochio* (Epirus); *turkie millet*, *kaffir-corn*, *negro-cane*, *bushel-maize*, &c, (English).

John Ardain in his notes on Pliny (l.c.) published 1723, observes that Scaliger (*Exercit.* (*1557*) *292*, *p. 869*) is responsible for the statement that his countrymen, the Italians, called it "*surgum*." Schweinfurth says that Petrus de Crasoentiis, about the year 1300 A.D., was the first author who definitely alludes to Sorgo. However in the editions of his *Agricultura*, dated 1471, 1571, and 1553, *melica* (*milica*) and in Italian versions *sagina* occur, but not *sorgo*. Mathiolus (*In Dioscoridem* (*1565*) *II.*, *407-8*) while repeating Ruellius' statement (*De Nat Stirp.* (*1537*), *p. 320*) that *Panicum* is called *Mellica* in Italy, affirms that the *Mellica* is the *saggina* of Etruria and the *sorgo* of the other parts of Italy. Porta (*Villa &c. 1592*, *p. 865*) accepting Pliny's statement that this millet came from India to Italy in the time of Nero, observes that it was called by the Italians *sagina*, *melica*, or *surga*. He then gives a derivation of the last name from "*surgo*-to rise" in allusion to its towering above all other crops. This is exactly the meaning of many of the Japanese and Chinese names for the crop. The Ethiopian *sorghum* to which Porta further on alludes, as more recently introduced into Italy, is doubtless one of the many white-grained forms, of which so much has been written by the 16th, 17th, and 18th century authors. Thus, for example, Bellonius (*Apud Clusium*, *Observ.* (*1605*) *II.*, *154*) speaks of the common people of Cilicia having to go so far for firewood that they had taken to the cultivation of a white-grained form of Sorgho, the stems of which they found excellent firewood. This particular plant, he adds, is known to the Arabs as *hareoman* [? misprint for *hartoman*—see *Dozy*, *Suppl. aux Dict. Arab*, *Vol. II.*, *p. 756*] John Bauhin (*Hist. Pl.* (*1651*) *III.*, *448*) is doubtless alluding to the same plant when he speaks of

SORGHUM vulgare, Pers. | Sorghum vulgare, Pers.,

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the Ethiopian Millet being the *arcoman* of Avicenna [who lived in the 10th century]. C. Bauhin (*Theat. Bot. (1658) I., 510*) mentions red, white and black forms of "*Sorgo*," some being early and others late crops.

The name Sorghum originated in Europe

Whether, therefore, we accept the derivation given by Kœrnicke or that given by Porta, it would seem that the word Sorghum, as it now exists, originated in Europe and is strictly speaking the name for the warm temperate grain-yielding races of the plant, the forms that correspond with the *rabi juár* of India presently to be described.

Early Indian travellers do not notice it

Few, if any, of the European travellers in India, whose writings as a rule are so fruitful of historic evidence, make any reference to this grain. Marco Polo, for example, who conducted extensive explorations in 1290 A.D. through a large portion of Asia (where the plant doubtless was being cultivated) makes no reference to it. It is not mentioned by Vasco da Gama who visited Calicut in 1498, nor by Garcia de Orta, Linschoten, Bernier, nor Tavernier. Yet we can have little doubt that it was extensively cultivated in India during at least the period of the explorations indicated. In the Ain-i-Akbari—the Administration Report of the Emperor Akbar for the year 1590—its price is quoted in a list of autumn grains, and in a further passage (*Gladwin's transl. II, 62*) it is remarked that—"*Jewary* and *Bajera* are the grains chiefly cultivated in the Subah of Guzerat." So again speaking of Khandesh (*Jarrett's transl II, 223*) we read "*Jowari* is chiefly cultivated, of which in some places there are three crops a year, and its stalk is so delicate and pleasant to the taste that it is regarded in the light of a fruit." It is, however, comparatively little grown on the Malabar Coast even to the present day, and was hardly likely, therefore, to have been seen by the traders and travellers who for the most part visited the coast towns Kœrnicke, who maintains with De Candolle, that as a cultivated plant it originated in Africa, not India, observes that it probably reached Asia by sea and not by land routes, as was often the case. But if that were so, we might expect to find it most extensively cultivated near the coast, whereas when we first learn definitely about it in India it is the staple food of the people who occupy the interior and drier tablelands, not the warm moist regions near the sea It is in fact met with approximately in regions where its presumed wild stock Sorghum halepense is most plentiful It is very possibly on this account that the plant is only doubtfully accepted by botanists as being described by Rheede (*Hort. Mal. (1678) XII., t. 60*), though a century later Rumphius (*Herb. Amb (1750) V., 194 t 75*) figures and describes the plant, calls it *harcoman* (? *hartoman*), and furnishes a review of some of the writings of the more important 16th-18th century authors. Rumphius adds," sown nearly everywhere in India especially the black kind .... but not amongst rice where the soil is watery, for *Battars* loves dry soil."

Akbar refers to it, 1590 A.D.

Rumphius figures it, 1678 A D

The plant must have had an Indian origin.

It is perhaps hardly necessary to elaborate further this historic sketch. While some of the known cultivated races of Sorghum doubtless *originated in Africa, Egypt, and even Europe, it is at least safe to affirm* that India, quite independently, evolved many of its most prized forms of that crop, and there is every probability that it even gave these in

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exchange for a few of the races which appear to have been derived from foreign countries. It is fairly evident, then, that the philological and historic data reviewed by De Candolle do not justify the exclusion of India from the list of original contributors to the world's supply. Woenig (*Pflanzen im alten Ægypten, 1886, 171-74*) who paid special attention to the evidence of ancient cultivation in Egypt arrived at the opinion that in prehistoric times Sorghum vulgare had found its way from India to North Africa It was there cultivated and gradually distributed southward until it reached Central Africa. He mentions a fresco depicting a harvest field on the walls of the grave of Amenembes in Beni Hassan, 2400 to 2200 B C., which he has no hesitation in declaring to have been intended for *Durra*. The fact that Roxburgh and other Indian botanists speak of having seen forms of S vulgare in a state of cultivation only is no argument against the Indian origin No one in any part of the world has recorded the discovery of truly wild form. Its accepted wild prototype (S halepense) is quite as plentiful in India as in Africa Schmidt who speaks of having found Sorghum "completely naturalised" in the Island of San Antonio is most careful to explain that he regarded his material as unsatisfactory seeing that he found only leaves and that these had been determined by comparison with certain plants preserved in the University herbarium of Göttingen If such a statement can be accepted as a justification for the opinion that the cultivation of the plant originated in Africa *and not in India*, then many similar passages might be quoted in support of India's claim. For example, Sir Walter Elliot, a botanist and linguist of no mean order, wrote (*Fl. Andh. 1859, p. 95*) that he had found a "? wild kind known as *konda-jonna*." In a further passage he remarks that the Tamil name for the plant *Cholam* was in all probability derived from the fact that it was the chief grain of ths *Chola* Country. It is quite customary in India for places to be named after abundant or characteristic plants—witness Almora (the country of **Rumex hastatus**) It is significant also that the grain of the wild S halepense (especially one particular variety) is in India systematically collected and eaten. It seems quite possible that this fact in itself denotes ancient knowledge, if it might not be accepted as pointing to abandoned cultivation and reversion to a wild condition.

Juar run wild

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SORGHUM vulgare, Pers. — Sorghum vulgare, Pers.,

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the Ethiopian Millet being the *areoman* of Avicenna [who lived in the 10th century] C. Bauhin (*Theat. Bot.* (*1658*) *I.*, *510*) mentions red, white and black forms of "*Sorgo*," some being early and others late crops.

The name Sorghum originated in Europe

Whether, therefore, we accept the derivation given by Kœrnicke or that given by Porta, it would seem that the word Sorghum, as it now exists, originated in Europe and is strictly speaking the name for the warm temperate grain-yielding races of the plant, the forms that correspond with the *rabi juár* of India presently to be described.

Early Indian travellers do not notice it

Few, if any, of the European travellers' in India, whose writings as a rule are so fruitful of historic evidence, make any reference to this grain. Marco Polo, for example, who conducted extensive explorations in 1290 A.D. through a large portion of Asia (where the plant doubtless was being cultivated) makes no reference to it. It is not mentioned by Vasco da Gama who visited Calicut in 1498, nor by Garcia de Orta, Linschoten, Bernier, nor Tavernier. Yet we can have little doubt that it was extensively cultivated in India during at least the period of the explorations indicated. In the Ain-i-Akbari—the Administration Report of the Emperor Akbar for the year 1590—its price is quoted in a list of autumn grains, and in a further passage (*Gladwin's transl. II*, *62*) it is remarked that—"*Jewary* and *Bajera* are the grains chiefly cultivated in the Subah of Guzerat" So again speaking of Khandesh (*Jarrett's transl II*, *223*) we read "*Jowari* is chiefly cultivated, of which in some places there are three crops a year, and its stalk is so delicate and pleasant to the taste that it is regarded in the light of a fruit" It is, however, comparatively little grown on the Malabar Coast even to the present day, and was hardly likely, therefore, to have been seen by the traders and travellers who for the most part visited the coast towns. Kœrnicke, who maintains with De Candolle, that as a cultivated plant it originated in Africa, not India, observes that it probably reached Asia by sea and not by land routes, as was often the case. But if that were so, we might expect to find it most extensively cultivated near the coast, whereas when we first learn definitely about it in India it is the staple food of the people who occupy the interior and drier tablelands, not the warm moist regions near the sea It is in fact met with approximately in regions where its presumed wild stock Sorghum halepense is most plentiful It is very possibly on this account that the plant is only doubtfully accepted by botanists as being described by Rheede (*Hort. Mal* (*1678*) *XII*, *t 60*), though a century later Rumphius (*Herb Amb.* (*1750*) *V*, *194 t 75*) figures and describes the plant, calls it *hareoman* (*I harteman*), and furnishes a review of some of the writings of the more important 16th-18th century authors. Rumphius adds," sown nearly everywhere in India especially the black kind . . . . . but not amongst rice where the soil is watery, for *Battari* loves dry soil."

Akbar refers to it, 1590 A.D

Rumphius figures it, 1678 A D

The plant must have had an Indian origin.

It is perhaps hardly necessary to elaborate further this historic sketch. While some of the known cultivated races of Sorghum doubtless originated in Africa, Egypt, and even Europe, it is at least safe to affirm that India, quite independently, evolved many of its most prized forms of that crop, and there is every probability that it even gave these in

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exchange for a few of the races which appear to have been derived from foreign countries. It is fairly evident, then, that the philological and historic data reviewed by De Candolle do not justify the exclusion of India from the list of original contributors to the world's supply. Woenig (*Pflanzen im alten Ægypten, 1886, 171-74*) who paid special attention to the evidence of ancient cultivation in Egypt arrived at the opinion that in prehistoric times Sorghum vulgare had found its way from India to North Africa It was there cultivated and gradually distributed southward until it reached Central Africa. He mentions a fresco depicting a harvest field on the walls of the grave of Amenembes in Beni Hassan, 2400 to 2200 B C., which he has no hesitation in declaring to have been intended for *Durra*. The fact that Roxburgh and other Indian botanists speak of having seen forms of S vulgare in a state of cultivation only is no argument against the Indian origin No one in any part of the world has recorded the discovery of truly wild form Its accepted wild prototype (S. halepense) is quite as plentiful in India as in Africa. Schmidt who speaks of having found Sorghum "completely naturalised" in the Island of San Antonio is most careful to explain that he regarded his material as unsatisfactory seeing that he found only leaves and that these had been determined by comparison with certain plants preserved in the University herbarium of Göttingen. If such a statement can be accepted as a justification for the opinion that the cultivation of the plant originated in Africa *and not in India*, then many similar passages might be quoted in support of India's claim. For example, Sir Walter Elliot, a botanist and linguist of no mean order, wrote (*Fl. Andh. 1859, p. 95*) that he had found a "? wild kind known as *konda-jonna*." In a further passage he remarks that the Tamil name for the plant *Cholam* was in all probability derived from the fact that it was the chief grain of the *Chola* Country. It is quite customary in India for places to be named after abundant or characteristic plants—witness Almora (the country of **Rumex hastatus**) It is significant also that the grain of the wild S halepense (especially one particular variety) is in India systematically collected and eaten It seems quite possible that this fact in itself denotes ancient knowledge, if it might not be accepted as pointing to abandoned cultivation and reversion to a wild condition.

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two Chinese forms, the one cultivated on a large scale on the sandy plains of Yan-tai; the other on the mica-schist hills above Sinenkoo. Hosie (*Three Years in Western China, 1890, 163*) refers to the tall millet, Sorghum vulgare. Lastly Rein (*Indust. of Japan, 1889, 37-51*), as well as a few other authors, describes *Sorgho* cultivation in Japan. He calls it *Durran*, the plant which in Japanese is known as *Merokoshi* and *Takakibi* (the high millet).

We may therefore conclude that in all probability the Sanskrit people first learned of this grain in India, but gave themselves very little concern regarding it. Everything, however, points to its having been *cultivated in the peninsula from remote antiquity, and in all probability* many of the races of the plant presently met with in that country have been locally originated.

References.

Other authors who may be consulted:—[Varthema's Travels, &c., 1503-1510, Hakluyt's Voy. iv 565; Fuchsius, *Pl. Hist.* (*1542*) *ccxcvi., p. 261; Tragus, De Stirp. Hist.* (*1552*) *II., 659; Pena et Lobel, Stirp. advers. nov.* (*1570*), *p. 14; Pr. Alpinus, Rer. Ægypt.* (*1735*), *p. 176; Parkinson, Theatr. Bot.* (*1640*), *1137, f. 3; Morison, Hist Pl.* (*1699*) *III., 196; Breyne, Prodr. II.* (*1739*), *83; Gronov. Fl. Orient.* (*1755*), *134; Host, Gram. Austriac.* (*1805*) *IV., 1, fig. 2 and Fl. Austriac.* (*1827*) *I., 71; Schmidt, Fl. d. Cap. Verd. Ins.* (*1852*), *158; Martius, Fl. Bras.* (*1883*), *II., ii., 270-272; Lambrecht, Berichten Land. u. Forstw. in Deutsch. Ost. Africa* (*1903*), *Vol. I., 398-402.*]

CULTIVATION.

CULTIVATION.

The *Judr* or Great Millet is a very important article of food with the labouring classes of India, and at the same time it has been very imperfectly dealt with by writers on Indian economics. *By the natives of India it is regarded as the most wholesome of* cereals. The seed is ground into meal and baked into cakes or boiled into a sort of porridge. The parched grain is eaten after being made into numerous special dishes flavoured with salt, sugar, or chillies, and the half-ripe grain (of certain forms or in certain localities) is regarded as a luxury, somewhat in the same way as green maize cobs are variously cooked and eaten. The chemistry of the grain and its value as an article of diet has been so fully dealt with in the Dictionary that it may suffice to refer to that publication.

Varieties and races.

Varieties & Races.—Speaking in a very general sense there are two great crops of *Judr*. Of these one is the *kharif*, which ripens in autumn. The majority of the *kharif* forms would fall under the botanical varieties bicolor, cernuus, and vulgaris proper. They have usually compact heads, the grains are more or less rounded and the floral envelopes almost completely glabrous. The second crop is the *rabi* or that which ripens in spring. It seems likely that most of

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the races placed in this position would be found to fall under the varieties hians, Roxburghii and saccharatus, and to approximate nearer to S. halepense than do those of the *kharif* series They have lax feathery panicles with the grains elongated and the floral envelopes often more or less hairy. As a rule the best grains are creamy white (the extremity only being darker coloured) and of a pearly lustre. It is customary for the grain to be slightly flattened near the apex, a peculiarity often much increased until in some forms the grain becomes almost hooked or even indented. The curved grains are often most highly prized for the purpose of being parched The glumes or envelopes are usually darker than the grains themselves and they may be awned or awnless. Thus in point of colour—the aspect on which 15th to 18th century writers laid so much stress—almost every shade from pure white to brown or even jet black may be found in either of the groups indicated above. In some forms the envelopes (chaff) are coloured and the grain husk (or seed-coat) white, in others the seed-coat also is uniformly or parti-coloured. So again the floral envelopes may firmly embrace and almost adhere to the seed, while in other conditions the attachment may be so slight that (as in certain barleys) the grain may deserve the description of being naked. It seems probable that Rheede may have had before him one of these *quasi*-naked *juárs* when he figured and described his *katou tsjolam*, to which reference has already been made Mr. Mollison (Inspector-General of Agriculture in India) says—" The most noticeable differences between varieties are that *kharif*, *i e*, rain crops or early varieties, are much more numerous than *rabi* or late varieties. Early or late varieties do best if sown at their approximate seasons. A *rabi* variety may or may not thrive if sown as a rain crop. None of the rain crop varieties are likely to succeed if sown in the *rabi* season." Having thus clearly recognised the existence of definite forms directly adapted to climatic and other conditions, Mr. Mollison would appear to withdraw slightly from his position, when he observes that development " depends more upon the character of the season, the kind and condition of soil, and the method of cultivation than upon differences between varieties." In the experiments conducted by the Farms in the Bombay Presidency it was established that forms of *juár* procured from *goradu* (light) soils, for example, those of Kaira and Baroda, could not be cultivated on the black cotton soils of the Deccan. But that circumstance can hardly be adduced in suport of a belief that centuries of selection have not directly adapted the plants into recognisable cultivated forms. Whether these should be called varieties in the strict botanical sense or only races, is of course a perfectly different issue. Environment is of necessity a primary factor in racial development.

Collection of information on varieties.

Some years ago the Government of India sanctioned a scheme for the systematic collection of specimens and information of economic products. Circular letters were to be issued to all district officers through their respective Governments, in which the extent of our present knowledge and requirements for the future were to be clearly set forth. The first letter of this kind on Sorghum was issued by me in April 1898 and in consequence a very large and highly instructive

BOMBAY AND SIND. Crops.

passed between the rows of seedlings. The principal crop is ready five months after sowing.

(C) The Rabi Juar of Gujarat:—In Broach this form of *judr* is called *shialu*. It is drill sown in September or October after one ploughing and several harrowings of the soil. The seed is sown at the rate of 7 to 8 lbs. an acre. The rows are 20 inches apart, and the seedlings appear in the furrows. The crop is twice intercultured with the bullock hoe. "As the ears begin to fill, the stalks are tied up to each other so that they may not be lodged." This is only necessary in a good year, with a heavy crop. Harvest takes place in February to March or five to six months after sowing.

MADRAS AND MYSORE. Area.

Madras and Mysore.—According to the Agricultural Statistics of *British India* 5,103,795 *acres were under cholam (judr)* in 1901-02. During the five previous years (1899-1902) the smallest acreage devoted to the crop was 4,375,168. The districts assorted according to the extent of this cultivation, during 1901-02 (omitting the three last figures), were:—Bellary (924), Karnál (765), Coimbatore (673), Cuddápah (493), Nellore (455), Anantpur (417), Kistna (416), Madura (223), Trichinopoly (167), Godávari (143), and Tinnévelly (101). In some of the districts not named its place is taken by *kumbu* (*bajra*) or by *ragi*. Thus where rice is either not suitable or not popular, an abundant food-supply is obtained by the people of South India from one or other of the Millets named.

Races.

Very little of a trustworthy nature can, however, be learned regarding the indigenous methods of cultivation of this plant. Most South Indian writers have concerned themselves with efforts to acclimatise the foreign Sorgo and Imphy. In the *Annual Report of the Department of Land Records and Agriculture* for 1901-02 mention is made of experiments with the *Irungu cholam*. In several other publications we read of as many as 96 different kinds of *cholam* being known. While that is so there has been published little or nothing of a practical and original nature from which useful particulars could be abstracted for the purposes of this work.* Mr. E. Krishna Rao (*Journ. Agric. Students Associat. 1886, II*) gives some useful suggestions regarding the crop. He, for example, speaks of the white *cholam* as a four months crop, sown in November and harvested in February. Other forms, *viz.*, the red, the yellow, and the small white *cholam* are sown in April and harvested in July. The land is ploughed several times and the seed sown broadcast. When the crop has grown a foot high it is watered and three or four days later hoed. If the soil be clayey and sufficiently

* While this number of the Agricultural Ledger was in the press a paper, entitled the Great Millet or Sorghum in Madras by C. Benson, assisted by C. K. Subba Rao, has appeared, being Bulletin No. 55 of the Madras Department of Agriculture.—Ed.

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manured 6 to 8 waterings and hoeings are considered sufficient. It is presumed that a yield of 500 lbs. per acre would be a safe average estimate. In the crop experiments figures have been published of actual returns that range from 220 to 1,690 lbs. In Mysore the published averages have been 453 to 800. MADRAS AND MYSORE. Outturn.

Berar & Hyderabad.—Mr. F. W. Francis in his *Agricultural Bulletin No. 3, of 1900*, has published one of the most valuable contributions to the study of *judr* that has as yet appeared. This was written by Mr. S. Harcourt King and while professedly an account of the crop in Amraoti is, in the opinion of Mr. Francis, fully applicable to all the Hyderabad Assigned Districts (Berar). BERAR AND NIZAM'S DOMINIONS.

Before furnishing the more remarkable points brought out in the above Bulletin, in order to preserve uniformity with other provinces, it may be desirable to furnish here the particulars of area of cultivation from the Imperial Agricultural Statistics. In Berar 2,884,875 acres were devoted to this grain in 1901-02 and during the five previous years the lowest return was 2,658,246 acres. Hyderabad (Nizam's Dominions) furnishes no returns. Mr. Francis says that *juár* is undoubtedly the most important grain crop of the province—more than one-third of the total cultivated area being devoted to it. It occupies fully 250,000 acres in excess of all other crops taken together. The Famine Commission of 1876 estimated that it absorbs 35·10 per cent. of the total cultivated area and 68·31 per cent. of the food area of the province. It certainly constitutes the staple food of the cultivating and poorer classes, while the stalks, known as *karbi* or *kadba*, provide the requisite cattle fodder during the greater portion of the year, when grazing is not available. It has been estimated that about one-fifth of the production is sold and exported. There are no less than 43 varieties of the plant grown and twelve of these come under the denomination *wani* (*bhátwani, jodwani, bawani, &c., &c.*) or forms that are not allowed to mature but are baked in hot ashes and eaten green, when the grain is tender and in the ear. One of these is distinguished under the name *andhali*, is completely covered by the husk and is not visible. Of the other forms four groups are formed according to their value as sources of bread. Area. Races.

These are :—

(1) The Yellow *judrs*, such as *dhdmand, lahi, ramkeli, amneri*, and *thengani*—the bread made from these is regarded as the best of all

(2) The Whitish *judrs*, such as *jagdhan, latura, motichur, shdlu* or *shdhu, &c.*—the bread made from these is hard and wanting in taste.

(3) The Reddish *judrs*, such as *gunji, ldlgunji, kadpdda*, and *ganeri*—bread made from these is of the same colour

BERAR AND NIZAM'S DOMINIONS Races.

as the grain. The *kadpáda* is a plump grain superior to *lálgunji*.

(4) The dirty-coloured *judrs*, such as the *kálbondi*. This and the *motichur* are seldom used for bread but are utilized in making *láhi* (parched grain).

The variety called *dhamna* is that most generally preferred. The *ramkeli* is selected for inferior soils and it is less liable to be affected by scanty rainfall. Seed is usually stored in ear in a convenient corner of the cultivator's house and not touched until sowing time arrives—handling is supposed to increase liability to be attacked by insects. It is regarded as essential not to store seed in proximity to tobacco, chillies, garlic, or *moha*. Immediately before sowing the seed is soaked in a solution of asafœtida and water or of cows' urine, the latter being the most general practice. The custom of soaking in hot water or pickling (as it has been called) in sulphate of copper, to destroy germs of smut, does not appear to be followed. Unless the soil is very hard or full of weeds, *judr* lands are ploughed once in four or five years only, and then in April or May. Instead the soil is simply harrowed. This is done three times and on the last occasion after the first fall of rain. The cultivator is alive to the value of manure, but his difficulty lies in obtaining it. *Judr* is, however, mainly cultivated without any manure or the land is manured once in two or three years only It is rated with cotton, sesamum, gram, wheat, *lakh* (Lathyrus sativus), and tobacco, but cotton is the most important because like *judr* it is a *kharif* crop It follows that any material expansion of the cotton area would mean a restriction of that of *judr*. The *judr* is usually grown as a mixed crop, with certain pulses. The continuous cultivation of *judr* deteriorates the soil and causes the growth of a parasitic weed *talupa*, *taluk*, or *tavli* (Striga lutea) which is checked by rotation, more especially with *til* (Sesamum).

Method of Cultivation

The first week in July is the best time to sow *judr* and if delayed till the last week the crop is believed to be inferior. Immediately the cultivator has sown his cotton crop, he gives attention to *judr*. The grain is drill-sown by an instrument called the *tiphan*. Sundays, Wednesdays, and Fridays are considered auspicious days for sowing and the sower begins operations by keeping his face either to the north or to the east. But the seed cannot be winnowed nor rubbed with cows' urine in the presence of a woman who has applied *kajal* (lamp black) to her eyes nor can *kajal* be used by the female members of the household until sowing is complete. Perhaps this may be a consequence of a belief that the use of the cosmetic causes the grain to be smutted.

Sowing is delayed not only by excessive rain, but by the absence

BERAR AND NIZAM'S DOMINIONS. Method of Cultivation.

of sufficient rain. A moderate and opportune fall of rain is needed for successful germination, but this is proportionate to the nature of the soil. A good soil requires less rain than an inferior one. When the shoots appear they are often seriously injured by an insect known as *maral*, but this is kept in check by timely rains. Cattle also do much damage. In fact until they are 6 inches in height the seedlings are tender; after that fairly hardy. Weeding is done three or four times at intervals of a fortnight. This is accomplished either by hand or by the *dowran* (or harrow), the latter loosens the soil and throws it up against the plants. When the plants come up too thick to ensure a good grain crop a certain percentage are uprooted.

Judr is never specially watered in Berar apparently, nor is it customary to grow the crop on land systematically irrigated. This is the rule for the grain crop, but when required to make up deficiencies of fodder, thickly sown and irrigated crops are taken. But fodder *judr* is not raised since the grain crop being so abundant the fodder supply is usually sufficient. *Judr* requires good rain in August and it comes into ear from three to four months after being sown, and ripens in five months (November to December). After having set its seed, rain is hardly necessary and the crop is not then liable to any special diseases except the depredations by birds, &c. But should rain hold off at the time of forming the ear, several insect and parasitic fungal diseases may appear and do much damage A good shower of rain is, in the belief of the cultivators, the only effectual remedy for these calamities In conclusion it may be observed that there is remarkably little *rabi judr* raised in Berar. Mention is made of this crop in connection with Baldana district.

Outturn.

It has been estimated that the value of the produce is ordinarily 25 per cent. in excess of the cost of cultivation and may even go up to double that amount. Mr. Francis concludes his most admirable paper (from which the above jottings have been abstracted) by a series of tables showing the acreage devoted to the crop from 1888-89 to 1897-98. In another place he gives the results of certain crop experiments. These show that in a good season the yield would be 833 lbs. to the acre and after making all allowances an estimate of 600 lbs., he thinks, would be a fair average production.

In Hyderabad it is stated that there are two crops of *judr*: the one sown from the 6th June to the 17th July and reaped from the 22nd October to the 30th November. The second crop known as white *judr* is sown between the 25th September and the 3rd November and reaped between the 17th February and the 15th March.

A writer in *The Indian Agriculturist* (*March 1886*) says the natives recognise many forms of the plant, six being *wani* forms. By far the most extensively grown, he tells us, is the *dhamni* or

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BERAR AND NIZAM'S DOMINIONS. Races in Hyderabad.

amnira. This is a yellow coloured grain with a bright glistening bran. It grows to a height of 10 to 11 feet, whereas the next most popular form—the *latura*—does not exceed six or seven feet. This is a white grain which when ground affords a fine white flour. The *jugdan* is a *kharif* form that has the advantage of ripening quickly and thus of allowing a *rabi* wheat crop to be taken from the same land. *Judr* is most successfully grown on black cotton soil. The land is prepared in March and April, but ploughing is rarely resorted to more frequently than once in 20 years. Manure is rarely given and the seed is drill sown. The crop takes five months to ripen.

UNITED PROVINCES. Area.

United Provinces of Agra & Oudh.—The *judr* area in Agra was returned at 2,090,660 acres and in Oudh at 343,568 acres during 1901-02, and during the five previous years the lowest return was in 1899-1900 when the two provinces showed an area of 2 million acres, and the year following their highest record, namely, a little more than 2½ million acres. The districts with the highest areas of production were (omitting the last three figures):—Jhansi (172), Mutra (159), Banda (152), Cawnpore (150), Hamirpur (143), [illegible] Allahabad [illegible]

more than 55,000 acres under the crop. In Messrs. Duthie and Fuller's account of this crop mention is made of three well-marked varieties: (1) the double-seeded form (two grains within the single husk), (2) a dwarf kind grown at Allahabad, (3) the variety known as *chdhcha* in Cawnpore, in which the grain is completely covered by the husk. In the Report of the Cawnpore Experimental Farm for 1901-02 mention is made of 90 varieties being under cultivation. The yield is given at 10 maunds grain for irrigated land and 8 maunds for unirrigated. In the reports of crop experiments returns ranging from 440 to 820 lbs. have been ascertained.

Races.

In many reports that deal with the districts above mentioned the statement occurs that *juár* is as universal in the *kharif* crop as wheat and gram are in the *rabi*. This remark is specially true of the black soils. In the Annual Reports of the Department of Land Records and Agriculture, frequent mention is made of this crop. Many varieties were experimented with at the farm, and *jogia*, *bansmati*, and *safeda* were regarded as the best. Subsequent to the date of the appearance of the Dictionary article on Sorghum no detailed paper has appeared regarding the cultivation of this plant in these provinces.

CENTRAL PROVINCES. Area.

Central Provinces.—These provinces had an area of 1,964,763 acres devoted to the crop in 1901-02 and during the five years pre-

vious their highest record was in 1900-01, *viz.*, 2,154,861 acres, and their lowest in 1898-99, 1,709,334 acres. The districts in order of importance may be here mentioned, the figure after each denoting the acreage, less the three last figures:—Nagpur (474), Wardha (329), Chanda (236), Chindwara (194), Nimar (196), Saugor (108), Betul (89), Hoshangabad (67), and Damoh (61). It forms the chief food of the working class, wheat and rice being alike but little used by them. The white *judr* constitutes the chief food of the people. In certain districts such as the Upper Godavery and the neighbourhood of Sironcha in Chanda district, a *rabi* as well as a *kharif* crop is obtained. Repeated mention is made (in reports on this plant) of a cold season form known as *ringni*. Some writers even speak of this as a hot-weather plant that has recently been successfully grown as a cold season crop It is commonly produced in the wheat fields of the rice-country of Ramtek and Umrer. Sir J. B. Fuller published in 1874 a *Note on the Outturn of Land under the Chief Crops in the Central Provinces* in which he gives most useful particulars regarding *judr*. He points out that the loss in *judr* through its being grown as a mixed crop with a pulse, (mostly *tur*) is very little indeed, so that the pulse is a clear gain. The yield per acre averages from 450 to 950 lbs., 500 lbs. has been accepted as the average standard. Mr. Fuller further points out that Nagpur, which has the largest district area, is also the chief importing province and that it draws on Berar. This is due very possibly to the place of *judr* being taken by linseed and cotton. In the *Settlement Report for Seoni (1900, p. 17)* it is observed that a few years ago *judr* was of very little importance in that district, but since the last three years it has been greatly extended, and has outrun the area under wheat In recent Annual Reports of the Director of Land Records and Agriculture, interesting particulars will be found of valuable experiments made with a view to improve the quality of the *judr* and the cotton grown, as also the methods of cultivation pursued in the districts of Bilaspur and Raipur. Trained ploughmen had been sent from the Government farm furnished with superior seed and improved ploughs to prepare and sow certain fields. The result would appear to have been so satisfactory that many indents were subsequently made by the cultivators for a supply of the improved seed. Demonstration farms have since been organised where local men, specially trained at the Government farm, will continue to demonstrate the advantages of the improvements recommended.

CENTRAL PROVINCES. Area.

Method of Cultivation.

Panjab.—According to the Official Agricultural Statistics the area under the crop in the Panjab might be regarded as giving evidence of decreasing popularity with the cultivators. In 1897-98

PANJAB. Area.

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SORGHUM vulgare, Pers. — Sorghum vulgare, Pers.,

PANJAB. Area.

the area was 2,386,049 acres, and it fluctuated downwards for the succeeding years till 1901-02 it stood at 855,025 acres, and in 1902-03 a slight increase took place, the area having been 1,206,775 acres. And what is more significant, the district returns show that whatever may be the cause for the decrease in production it has practically taken place throughout the province. The districts of chief importance are Jhang (120, omitting the last three figures), Dera Gazi Khan (95), Hissar (declined from 248 to 13), Rohtak (from 267 to 29), Gurgaon (from 133 to 56), Karnal (from 201 to 61), Ludhiana (from 104 to 22), Ferozepore (from 147 to 46). In certain crop experiments performed in the Panjab in 1892, the yield ranged from 276 to 800 lbs. per acre.

Races.

There are said to be many races of the grain, and in most districts it would appear as if special fodder (*chari*) forms had only recently been systematically cultivated. The Gazetteers afford useful particulars, but it would seem that since the date of Baden Powell's *Panjab Products* no publication has discussed the *judr* cultivation of the province as a whole. The Dictionary article should therefore be consulted since it gives an abstract of the chief opinions hitherto published.

NORTH-WEST FRONTIER PROVINCE.

North-West Frontier Province.—*Judr* is not an important crop in Hazara, Peshawar, Kohat, Bannu, and Dera Ismail Khan, the total acreage having averaged for the province 13,174 irrigated and 46,445 unirrigated land.

BENGAL AND ASSAM.

Bengal & Assam.—Although grown by the hill tribes to a limited extent, *judr* cannot be regarded as an important crop in these provinces. The unimportance of *judr* and in fact of all millets may be gathered from the opinion of the Famine Commission, namely, that famine in Bengal meant essentially the loss of the rice crop sown in April to June and reaped from November to January. The loss of the *bhadoi* or intermediate crops, which consist largely of India-corn, millets, etc., would not produce famine, not even scarcity.

Area.

The area under the crop is in Bengal less than 150,000 acres and in Assam the figure of 5 acres has been quoted. In the Annual Report of the Bardwan Experimental Farm (1901-02) particulars are given

Races.

of experiments with black-seeded and also red-seeded forms as fodder crops. Further experiments with other forms are alluded to by the Director of Agriculture in his Annual Report for 1902-03.

BURMA.

Burma.—In the Official Agricultural Statistics this province is referred to two sections, Upper and Lower Burma. In the former the area under *judr* is important and has further been manifesting a

Area.

constant tendency to expand. In 1897-98 it stood at 615,145 acres and in 1901-02 at 1,028,844 acres. In Lower Burma—the rice-country—the crop is very unimportant, in 1901-02 there were only

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BURMA.

1,000 acres under the crop. The chief districts are Myingyan (237, omitting as usual the last three figures), Pakokku (210), Lower Chindwin (186), Magwe (156), Sagaing, (95), Meiktila (94), &c. The results of the crop experiments have shown the yield to be from 328 to 875 lbs. an acre.

Outturn.

Varieties.

Recent Settlement Reports have furnished some useful particulars regarding this crop. Speaking of Myingyan we read that "the seed was said to have been introduced" after the famine of 1856-57. Mr. Blanford reports having seen it in Pagan in 1862. There are two forms recognised—1. *sanpyaung*, grown for human food: it has a round white seed with yellow husk, and 2. *kunpyaung*, grown for fodder but not exclusively so; it has both red and brown grains. Both crops are sown in July and August and gathered in December and January. The stalks which often run up to 18 feet in height are given to cattle after being chopped up and mixed with water.

Speaking of the Meiktila district we read in the Settlement Report that *judr* is one of the chief up-land crops. It is in greater request as an article of food in the western than in the eastern portions of the district owing primarily to the fact that the scope of the cultivation of paddy is somewhat limited in the former. There are three kinds,—1. *Kun-pyaung*, has a reddish-brown seed, is not deprived of its husk on being threshed and gives the highest return. 2. *San-pyaung*, gives the lowest return in proportion to the seed sown, since in the process of threshing and winnowing it is entirely cleared from the husk, so that nothing but the little pearly yellowish seeds remain. It has a better appearance than the *kun-pyaung*, and yields after being milled 11 as compared with 8 from the *kun-pyaung*. 3. *Pyaung-nel-si*: this is not very extensively cultivated. It has a jet black husk and forms (like *kauk-hnyin* rice) a glutinous mass when cooked and is used for cakes and other sweet confections. The *juár* is sown in August and September and reaped in January and February, being a six months crop. It grows well in paddy fields provided water is not allowed to stand in the fields, and when scarcity of water prevails it often takes the place of paddy. The ground is prepared by harrowing the surface at least ten times and the seed is then broad-casted.

Fodder Supply.

FODDER.

Ripe & Green Stems.—The *juár* crop is not alone of value as a food for man. Its stems constitute the chief cattle fodder (*chari*) of a large portion of India. The first signs of famine directly induced by the loss of the *juár* crop are the starvation and death of the cattle. It thus follows that in India it is the ripe stems and leaves

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SORGHUM vulgare, Pers. | Sorghum vulgare, Pers.,

FODDER.

(the straw, it might be called) which constitute the Indian *juár* fodder. Here and there special races of the plant are grown as a supply of green fodder. Mr. Mollison speaking of the Bombay Presidency mentions some six indigenous forms of fodder *juár*, and as these are possibly representative for the whole of India an abstract of his information may be useful :—

Varieties used for fodder in Bombay.

1. **Sundhia.**—Perhaps the best fodder variety. It grows to perfection in North Gujarat on deep alluvial sandy or sandy loam soils either as a rain crop or under irrigation in the hot weather, and in the Deccan it does only moderately well as an irrigated crop, either in the cold or hot seasons. It should be sown broad-casted 50 to 60 lbs. of seed to the acre. When in flower it should stand very dense and be 9 to 11 feet in height with stalks no thicker than those of strong wheat. There are two sub-races of this plant known as *farfaria* and *amaria* (*See Experimental Farm Report, Bombay, 1898, p. 4.*) According to many writers the *shalu* is a special rabi form of *sundhia.*

2. **Dudhia.**—This is met with on the light coloured soils of Kaira and Baroda. The head of the grain is small and dense. It is usually grown mixed with *sundhia.*

3. **Nilva.**—This is the best Deccan (Poona) fodder for the monsoons. It is sometimes grown for its grain, but is chiefly of value near populous centres as a supply of fodder. It has a small moderately dense head of inferior seed, but is a stronger more leafy plant than *sundhia*, hence the seed to the acre should not exceed 40 to 45 lbs. It does best on medium black soils and does not mature quickly. If cut green and a fair stubble is left, a second or even third crop may be obtained, if rain be favourable or irrigation given. This is a valuable property possessed by certain forms of *juár* only. It has, moreover, in the Deccan become so inured to climatic conditions often highly unfavourable that it will survive when other forms fail. Mr. Mollison observes, "We have repeatedly grown at the Poona Farm over 30,000 lbs. per acre of green fodder from *nilva.*" (*See Experimental Farm Report, Bombay, 1896-97, p. 3.*).

4. **Utávli** is another Deccan form with loose upright heads of grain. It grows more quickly than *nilva* and is particularly suited for sowing midway between the *kharif* and the *rabi* seasons. It does very well on moderately light as also on medium black soils. As a cold weather irrigated crop it does better than *nilva.* (*See Farm Report, 1897-98, p. 27, also 1902, p. 3,* where the dry weight outturn per acre is given as 10,623 lbs.)

5. **Hundi** and 6. **Kálbondi** are recommended for cultivation as irrigated crops and should be sown any time between November and February. They do best on medium black soils of fair depth. The stalks are tall and rather coarse and woody. The seed should be broadcasted 40 lbs. an acre and the field irrigated every 10 days in the cold season, and every 8 days in the hot weather. Both these crops, if cut for fodder, before they reach maturity, send up a second crop and several stalks shoot from one stool.

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Mr. Mollison further observes :—"No other crops can compare with the sorghums in yielding a heavy weight of green fodder of good quality. Succulent fodder of this class is specially valuable in the hot weather for all farm animals, and *hundi* and *kálbondi* are the most suitable varieties yet found for the purpose." The Annual Reports of the Director of Land Records and Agriculture as also the Reports of the Experimental Farms in Bombay have for years past contained much useful information regarding Sorghum and a few that are of special value have been cited above. FODDER. Yield.

In the Panjab Sorghum fodder (*chari*) is a fairly important crop. The Gazetteers and Settlement Reports as also the Annual Reports of the Director of Agriculture contain useful particulars, but it is impossible to ascertain the special local forms that might correspond with or be supplemental to those briefly indicated regarding Bombay. So in the same way many reports and technical publications refer to the fodder (*karbi*) of the Central Provinces, and also of the United Provinces. It is stated, for example, in connection with the Nagpur Farm that it had been ascertained that an economy was effected by giving to cattle chopped canes in place of entire canes of sorghum. The Annual Reports of the Department of Land Records and Agriculture and of the Saidapet Farm in Madras give certain particulars of experiments that had been made with the acclimatisation of foreign sorghums and to some extent also with the indigenous *cholam*, but very little of a critical nature has as yet been published regarding special fodder forms of the plant peculiar to the Presidency and of the native practices in their production. As fodder in Panjab. In the Central Provinces. In Madras.

Ensilage.—Mr. Mollison describes the manner of preserving Sorghum fodder followed in the Southern Maratha Country. "The bundles are built into neat oblong heaps in the field. Each heap is built with a slope from the ground to the ridge, and when complete is protected along the sides, ends and top with big lumps of black soil, which are built or packed closely together. These heaps when complete look like large boundary marks. Cattle can freely graze over the stubble, but can get no access to the stored fodder." Dr. Voelcker has expressed himself as opposed to the introduction into India of the European methods of siloing Sorghum fodder. The reports published by the Experimental Farms of India are as a rule *unfavourable*. ENSILAGE.

Mr. Mukerji (*Handbook of Ind. Agric., p. 255*) says that Sorghum fodder may be sown "in May, and sowings should continue through June and July, that there may be a succession of fodder crops of first, second, and third cuttings from July to March or April, a portion of which can be dried and preserved for use from April to June. The dried stalks should be stacked and thatched."

Poisonous Property.—It has been already observed that the name *bikhonda* given to the wild S. halepense may be intended to denote the well-known poisonous property which that grass some- WHEN IS SORGHUM POISONOUS

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SORGHUM vulgare, Pers. Sorghum vulgare, Pers.,

WHEN IS SORGHUM POISONOUS?

times manifests It may perhaps be accepted as a further proof of the derivation of at least the fodder-yielding cultivated forms of **Sorghum vulgare** from this wild plant, when it is added that under certain circumstance, the cultivated Sorghums also become poisonous. In this connection attention may be invited to the fact that the Hemp Drugs Commission in their Report (*p. 156*) and more recently the Excise Commissioner of the Central Provinces have made known a new use of the root of the *judr* plant that seems to have escaped the observation of previous writers. It would appear that *judr* root is employed to increase the potency of Indian hemp (*bhang* and *ganja*) as also country liquor, but is viewed as too powerful to be used by itself. A poison residing in the roots is certainly remarkable and worthy of the most careful and searching future inquiry, but it may be added that it is said to occur also is the root of rice, and so far as *judr* is concerned in the cold weather or *ringni* (Central Provinces) and *shalu* (Bombay) varieties only.

Toxic body in the root of some races.

In the *Dictionary of the Economic Products of India* (*Vol. VI., Pt. III.* (1893) *p. 304*) it was observed that whether due to an insect (as the natives appear to think) or to some physiological change in the growth of the plant, due to climatic disturbances, the *juár* stems become occasionally poisonous. The occurrence of this poisonous property is moreover often simultaneous over a large tract of country, appearing and disappearing within certain fixed limits of time and locality. It would thus seem that the effect of climatic disturbances in modifying the quantity and quality of the crop has not received the degree of consideration which it demands. Need it, therefore, be added that the study of the races of **Sorghum**, in relation to climate and soil is of the very first importance. Since the above suggestions were offered, more especially regarding the possible physiological changes in the growth of the plant, considerable progress has been made. Veterinary-Captain Pease (*Agricultural Ledger, 1896, No. 24*) recorded the death of a large number of cattle at the Sirsa fair, due to their having eaten *judr* stems. A parcel of the stems was subsequently examined by Mr. T. Stephenson, Analytical Chemist, Bombay, and found to contain 75 grains of nitrate of potash per ounce weight of the plant. Moreover, that salt was found to be unevenly distributed throughout the plant, being most abundant in the stem at the nodes or junctions of the leaves. Captain Pease observes: "There can be no reasonable doubt that in the cases of poisoning from the plant the cause is the presence of large quantities of nitrate of potash in the stems" On the other hand, Dunstan and Henry [*Philosoph. Trans. of the Royal Society, 1902* (*199 A*), *399*] in a very learned paper on the *Cyanogenesis in Plants* have shown that the poisonous property of immature

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Sorghum is due to the presence of prussic acid originating in a new glucoside named *dhurrin*. They have furnished a full account of the formation of the poison and of the enzyme which has the power of hydrolysing *dhurrin*. But it should be observed that these authors expressly say that the prussic acid has only hitherto been detected in "the young plant." And they add, "It appears that animals, indigenous to the countries in which these plants are native, refuse to eat them in the earlier and poisonous stages of growth." WHEN IS SORGHUM POISONOUS?

The poisoning referred to by Pease occurred in consequence of cattle having been given plants stunted through the failure of the rains and the abnormally high temperature that prevailed at the time. The fodder therefore certainly did not consist of young plants or thinnings from a field of seedlings.* Capt. Pease further remarks that it is a very general belief that Sorghum rendered poisonous through being stunted might subsequently become innocuous by a liberal supply of rain, or even (he suggests) through washing thoroughly the prepared fodder before it is given to the cattle. Dunstan and Henry, on the other hand, observe that according to Floyer the *Dhurra* "is planted chiefly in order to shade the Arachis (ground nut), to which it also affords protection in forming a poisonous hedge. The 'thinnings' of the young millet are often strewn around a cultivated crop, and the neighbours are warned to keep their cattle off. The poison is most intense when young plants, one foot high or less, are kept without water for a long time, and such unwatered young plant is highly toxic to cows."

By way of concluding this brief review of information the following references to more recent opinions may be useful. In the *Board of Trade Journal* (*Supp. 1903, XIV*) it is observed "the amount of prussic acid obtainable from *Dhurra* is in the case of plants 18 inches to 24 inches high ·25 per cent., beyond this stage the amount rapidly diminishes, and in the mature plant the cyanogenetic glucoside has entirely disappeared." As having a bearing on the belief that the roots also are poisonous reference may here be made to an article in the *Journal of the Society of Chemical Industry* (*XXII, 1903, p. 226*), in which, while discussing the presence of prussic acid, it is affirmed the poison occurs most abundantly in the stalks, less in the leaves, and not at all in the roots. Brunnich (*Queensland Agric. Journ., XIII, 1903, p. 94, also Journ. Chem. Soc., No. 448, pp. 788-796*) in his paper on Hydrocyanic Acid in Fodder Plants says that the quantity is increased by high nitrogenous manuring. He further observes that as soon as the seeds are ripe the plant becomes innocuous. The poisonous nature of Sorghum as fodder has aroused much attention in Australia, and Dr. W. Maxwell in the *Queensland Agricultural Journal* has contributed useful additional particulars (*see Vol. XIII. (1903), pp. 59,* References.

* Lieut. Col. D. St. Grant in 1903 reported a case of cattle-poisoning near Ranchi, Bengal, as the result of the eating of young shoots springing from old roots.—ED.

WHEN IS SORGHUM POISONOUS?

93, 293, 473). The subject has also been taken up by various investigators in the United States of America (*see Agri. Dept. Exp. Stat. Record XIV, 1903, pp. 298, 701, 921*). Slade has, for example, pointed out that a very great variability exists in the amount of prussic acid present in the different varieties of the plant. An extensive series of quotations might be given in support of the Indian belief that Sorghum only becomes poisonous when stunted in its growth through insufficient rainfall and abnormally high temperatures. In no instance has an Indian writer recorded so pronounced an opinion regarding the poisonous property as that given above in connection with Egypt. Nowhere in India is the poisonous property of withering seedlings taken advantage of to protect other crops from the depredations of straying cattle. Dr. Voelcker (*Report Improv. Ind. Agric., 1893, p. 92*) and one or two other writers say, however, that Sorghum is grown around the borders of fields "to keep cattle from trespassing on to the crops." "Where hedges are not grown, it is not infrequently the case that a few rows of a special crop, such as linseed, hemp, or Sorghum are put round a field in order to protect the main crop." [" *Sorghum as a Forage Crop*" *by* Williams *in U. S. Farmers' Bulletin, No. 50 (1899)*; "*Forage Crops*," *by* Lyon *and* Hitchcock, *U. S. Bur. of Plant Industry, Bul. 59, 1904*.]

Sugar Sorghum or Imphee.

SUGAR SORGHUM.

It may have been noted, from some of the observations already made, that forms of Sorghum with sugar-yielding stems must have been well known to the people of India many centuries ago, and thus long anterior to any recorded introduction of these plants from China or Africa. It may also be pointed out that since the word *Sorgo* (*Sorgho*) originated in the South of Italy, it would be a safe deduction that it had been first applied to (and had best be restricted to) the grain and fodder forms that are believed to have been produced in Europe, in North Africa (Egypt), in the United States of America, in the more northerly tracts of China, and in the more elevated regions of India. In other words, it would be useful if the word *Sorgo* were exclusively given to the warm temperate, in contradistinction to the tropical forms. In the same way the name *Imphee* (which means sweet-cane) was introduced into Europe and America about the year 1854 by Mr. Leonard Wray, as being the Kaffir name of the special sugar-yielding plant which he found in South-East Africa and which he urged so warmly as deserving of the attention of the sugar-growers of the world. Some few years previously identically the same plant had been sent from China to France by Montigny and came rapidly into favour as a rich fodder grass. It seems, therefore, desirable on both historical and botanical grounds to assign the name *Imphee* to the sugar-yielding and *Sorgo* to the temperate grain-yielding forms of the species. By most writers these names are, however, used synonymously, a usage justified by the

Discovery of Imphee.

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fact that a sugar-yielding form may, when carried from one country to another, become a grain or fodder form. *The separation recommended*, though it would be useful, could not therefore be arbitrarily enforced, the more so since it by no means follows that all the sugar-yielding stock now known came from Africa or China, any more than all the *Sorgos* originated in Italy, India, China and Africa have each more or less parallel assortments of cultivated races of Sorghum vulgare, both temperate and tropical, and interchanges have no doubt taken place for centuries past between all three countries. The majority of the forms of *Sorgo proper and of Imphee proper belong*, however, to the botanical assemblage accepted as derived from the same variety (or closely allied varieties) of the species To a large extent also they correspond with the *rabi juár* of the plains of India. *They are the plants most generally prized as sources of fodder because* of being sweet and of possessing the property of rattooning and of sprouting from stools after being cropped Lastly, as already pointed out, they are the cultivated conditions which approximate most nearly to the wild plant S. halepense—a plant indigenous to large tracts both of India and of Northern Africa. The separation, moreover, of the plants that may be accepted as corresponding with the *Sorgo* and the Imphee, leaves a vast assemblage of tropical forms such as the *judr* proper of India. While these are doubtless represented both in Africa and China, a stronger case exists for at least the majority being accepted as indigenous to India, than can be made out for either of the other countries named. The separation of the forms of Sorghum met with in India into two great groups that may be spoken of as corresponding with S. halepense on the one hand and with S. vulgare on the other, was urged in the *Dictionary of Economic Products*. That isolation seems of infinite practical value and should be kept clearly in view in every attempt to improve the Indian stock.

Affinity of sugar yielding races.

Attempts at cultivation in India

The reports and journals of our Agricultural Departments, Experimental Farms, and Agri-Horticultural Societies literally teem with accounts of the efforts that were made from one end of India to the other to acclimatise the Chinese and African sugar-yielding Sorghums. And in *many cases plants which in all probability should have been treated as rabi* were grown as *kharif* crop; failure being a natural consequence. After a careful perusal of the extensive literature concerning acclimatisation experiments, two convictions arise in one's mind: *first*, that no practical result of any great value has been attained: and *second*, that meantime the study of the indigenous forms has been utterly neglected. It is impossible even now to say for certain what forms of *juar* and *Sorgo* exist in the provinces of India or to furnish a concise statement of the systems of cultivation pursued. We read, for example, that in Bikanir and Ajmer a form of sugar-yielding Sorghum known as the *Alipura*, been known and cultivated from time immemorial and used in

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by H. W. Wiley, Chemist to the Dept.; Year-Book 1897, p. 80: 1899, pp. 242-3; Exper. Stat. Record, X., 1899, p. 345. XI., 1900, pp. 141, 319, 883; XII, 1901, pp 236, 547, 942. XIII., 1902, pp. 42-3, 242; XIV, 1903, p 757; U S. Farmers' Bull. Nos 90, 92 (1899); Agric. Gazette, 1891, p 134: 1894, p. 578; Journ. Agric., S Australia, V. (1902) p. 876; Rev. des Cult. Colon. II. (1902), p 51; Journ. Soc. Chem. Industry. XXI., (1902), p. 628. SUGAR SORGHUM

Spirit.—Many writers allude to the fact that the Africans manufacture a sort of beer from the grain of Sorghum. One of the natural results of the inquiry into the sugar sorghums was the question of their being utilized in distillation. In 1884, Messrs. Minchin Brothers of Aska, Ganjam, reported that the juice of Sorghum was most valuable to distillers. The spirit prepared is said to have tasted much like rum, but after being opened was liable to throw down a gelatinous looking substance. Nothing further has been heard on the subject in India, and in the United States of America it has generally been said that change in the fiscal law of the country would be necessary before it could be utilized SPIRIT MAKING. Suggested in India—Dropped

Industrial Uses.—The value of the thicker and drier stems as fuel is fully understood in India though they are only incidentally utilized. In fact the plant is so very valuable as a fodder for the cattle that remarkably little is, as a rule, available for fuel The culms are sometimes made into pens, more especially those of the wild species. In Southern Europe and America a special form of the plant known to botanists as **var. technicum** is specially grown in order that (after the removal of the grain) the rigid, strong, much-branched fruiting shoots may be employed as natural brooms and special qualities for small hand-brushes or whisks Mr. W. J. Hannan (*Textile Fibres of Commerce, 1902, p. 158*) gives incorrectly a photograph of the compact headed forms of Sorghum as being that of the Broom-Corn. Reference has already been made in the paragraphs devoted to History to the leading German authors, who have written on this subject Mr C P Hartley has given a detailed account of this special product in the *Farmers' Bulletin, No. 174*, published by the United States Department of Agriculture in 1903 The form of the plant that should be selected for that purpose, Mr Hartley tells us, "differs from all the others of the same species in having panicles or seed heads with much longer, straighter, and stronger branches or straws." "It is for the seed heads, or 'brush' as they are called, that the plant is cultivated." It would seem there are two chief forms, known as "standard" and "dwarf." The former has longer and stronger straws and is accordingly used for large brooms, while the latter is shorter, but has fine, straight, elastic, and uniformly green straws The dwarf fetches the highest price, and is used for hearth brooms, whisks, and cloth brushes. [*Conf. Dodge, Useful Fibre Plants of the World, p. 59*] BROOM CORN

Trade in Juar.—It is exceedingly difficult to furnish any very definite statement regarding the traffic in the products derived from Sorghum vulgare in India, for the simple reason that as a rule the official statistics treat of the two millets—*juár* and *bájra*—conjointly. It would, however, be fairly safe to assume that ⅗rds of the TRADE.

SORGHUM vulgare, Pers. | Sorghum vulgare, Pers.,

TRADE.

quantities recorded are in reality *judr*, the balance being *bajra* The estimate of total production given above for *judr* alone comes to 100 million cwt. of grain The exports of *judr* and *bajra* together during the past five years have averaged 738,000 cwt.; ⅔rds being *judr* we thus learn that the total exports do not seriously exceed one-half per cent. of the production. *Judr* is, therefore grown primarily to meet the food necessities of the people and not (as in t[he] case of rice in Burma) as a rent-paying article of export. The ar[ea] of its production can alone be curtailed by the consumption of so[me] other article of food either produced or imported. The necess[ary] nature of the crop may be gathered from the interchanges which co[n]stantly take place between the provinces of India during seasons [of] scarcity or famine. And this is an interesting new feature of Indi[an] economy in direct consonance with the rail and road facilities [of] interchange.

The quantities of *judr* and *bajra* conjointly shown as carried by rail and river average about 6 to 7 million maunds in normal years. The maund varies in the different provinces, but in Bengal it is 82⅞lbs. The famine of Western India at the end of the past century caused a demand for these millets responded to by the other provinces. In the year 1899-1900 the rail and river traffic came to close on 16 million maunds; in 1900-01 it stood at 12½ million; in 1901-02 at 11¾ million maunds, but in 1902-03 it fell to its normal condition of 6⅞ million maunds Now, during these years of scarcity and famine, Bombay Presidency imported in 1899-1900, 6 million; in 1900-01, 6⅞ million; in 1901-02, 4½ million; and in 1902-03, 2 million maunds, while the town of Bombay itself took in addition 3½ 1, ⅞, and 1¼ million maunds These supplementary supplies were drawn from Madras, the United Provinces, Sind, &c.

Turning now to the records of the coastwise traffic we obtain a similar indication of the inter-dependence of the provinces of India for this all-important food-stuff, especially during abnormal years or local climatic disturbances. The returns of imports show that Bombay draws on Sind, Madras, and Burma and exports to Kathiawar and Kach.

PRICES.

Prices.—The official returns (*Prices and W[eights] in India*) some useful particulars. The mean average [price of] *judr* India during the years 1871-75 is taken as comparison of relative prices in the districts, also of accidental disturbances. A caref[ul] reveals the fact that with every extens[ion] trade a balance or adjustment in fo[od] like *judr* may have been abnormal facilities of export, while other article[s]

S. 2424-2500.

PRICES.

in value with the additional supplies obtained. During the quinquennial period 1896-1900 (which includes a term of scarcity and famine) the mean average for the whole of India was 153·6 and in 1903, when the effort of the famine had been effaced, it stood at 109·23, but if three provinces be removed from consideration, namely, Berar, the Panjab, and Sind, the mean average for the whole of the rest of India becomes 1·006. In the three provinces named (except some districts of the Panjab) *judr* never seems to have been procurable at the price expressed by the standard of 100. As exhibiting the actual prices of this millet, it may be here stated that, expressed in seers (=2 lbs.) and decimals of seers, obtainable for one rupee (or 1*s.* 4*d.*), the returns of Burma in 1903 show 24·76; Bengal 19·75; Agra 22·5; Oudh 25·21; Rajputana 23·51; Central India 28·14; Panjab 21·88; Sind and Baluchistan 18·67; Bombay 22·84; Central Provinces 25·53; Berar 22·44; Nizam's Territories 20·81; Madras 26·15; and Mysore 26·24. Thus the provinces where this grain is normally most expensive are Sind, Bengal, Nizam's Territories, and the Panjab.

The most significant feature of the internal trade returns is perhaps the circumstance that Bengal practically takes no part in the traffic. Millets are in fact very little consumed in Bengal. Another feature of the trade may be said to be that the great producing areas export to tracts of country inhabited by simple agricultural communities or to regions where modern civilization with its concomitant luxury has not penetrated to any material extent.

S. 2424-2500.

G. I. C. P O.—No. 110 R. E. P.—26-4-1906.— H S.

(Special Veterinary Series, No. 18.)

THE

AGRICULTURAL LEDGER.

1905.

HORSES.

(STOCK DISEASES.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. IV., H. 414–436*]

Provisional Report on "White Scour" in young stock at Probynabad, by CAPTAIN F. S. H. BALDREY, F.R.C.V.S., *Professor, Panjab Veterinary College.*



CALCUTTA:
OFFICE OF THE SUPERINTENDENT GOVERNMENT PRINTING, INDIA.
1905.

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THE

AGRICULTURAL LEDGER.

1905.

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(Special Veterinary Series, No. 18.)

THE

AGRICULTURAL LEDGER.

1905.

HORSES.

(STOCK DISEASES.)

[*Dictionary of Economic Products, Vol. IV*, H. 414-436.]

Provisional Report on "White Scour" in young stock at Probynabad, by
CAPTAIN F. S. H. BALDREY, F.R.C.V.S, *Professor, Panjab Veterinary College.*

Observations.

In accordance with instructions received from the Principal, Panjab Veterinary College, I visted Probynabad on the 19th, 20th, and 21st of June. Previous to this I had received the body of a foal dead of the disease, and my observations on this are as follows. The *post-mortem* of the foal revealed extensive mucoenteritis with great destruction of the mucous membrane of the intestine.

The mesenteric lymphatic glands were enlarged and contained an excessive amount of a milky secretion. The mesenteric blood vessels were engorged The spleen, pancreas, and kidneys were normal. The liver slightly enlarged, bile-stained, and friable. The lungs showed broncho-pneumonia slightly, the bronchial tubes being filled with a thick frothy mucus The cadaver was considerably decomposed, which greatly hampered bacteriological investigation. Material was, however, preserved for histological examination.

In the presence of innumerable organisms both *ante* and *post-mortem* it was impossible to make satisfactory cultures.

White scour suspected.

From the history of the disease and its symptoms I was at once led to believe that it was white scour as it occurs in calves, and which was investigated by Nocard and Mettam in Ireland in 1902.

On making sections of the intestine and the mesenteric glands I was enabled to demonstrate the presence of a few bipolar staining organisms of the Pasteurella variety, which is the cause of white scour and lung disease in calves, as demonstrated by Nocard and Mettam.

HORSES.	Provisional Report on "White Scour"

Visit to Probynabad.

On account of the amount of decomposition and the presence of enormous numbers of bacteria of other varieties it would be impossible to definitely say that this is absolutely and undoubtedly the cause. It is, however, sufficient to make it extremely probable, and in order to definitely prove the case it will be necessary for me to go to Probynabad and make investigation of the matter on the spot, so that I may obtain fresh material.

Mr. Montgomery at Mukhtesar has also kindly made some section preparations of the tissue, which I sent to him, and he also found the bipolar organism which I have mentioned.

It was unfortunate that on my visit to Probynabad on the 20th June I should find no animals affected. There had been a number of cases, but the last was just dead and no fresh case had occurred.

I should esteem it a favour if I might be allowed to go to Probynabad when a number of foals are expected to be born, and to remain there until material is forthcoming. As there are at present about 35 deaths out of 75 births from this disease in the year, the seriousness of it may be imagined.

Strangles.

I noticed in my recent visit that several sucking foals were suffering from strangles. This in connection with the presence of white scour would point to a very foul condition of the runs. At this I am not surprised, as the farm has been in existence some 40 or 50 years and only certain parts of it are let off for young stock runs and breeding; these are not sufficiently fenced to allow of any one part having a complete rest from the stock. The grass paddocks that are irrigated and in which young stock are turned for limited periods are small and difficult to thoroughly clean after the stock have been in them. The want of water prevents the larger runs from being occasionally cultivated and so having a complete rest and change from the fouling influences of the stock.

To these causes I think a good deal of the disease is due; I mean that these existing conditions facilitate the growth and reproduction of such parasites as the Pasteurella of white scour and the streptococcus of strangles.

I had neither time nor opportunity to make a thorough investigation of the conditions during the short time I was there; moreover the weather was inordinately hot, and I could not possibly have made a complete examination of the place. This I should like to do during the next cold weather, accompanied by some one of the 11th Bengal Cavalry, who is acquainted with the place, when I could make practical suggestions, which I cannot pretend to do in this provisional report.

Description of disease.

I append herewith a short account of the disease known as white scour which I think would make a useful addition to the Civil

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Veterinary Department Ledger series. There is very little literature of its effect on foals, and this makes the disease at Probynabad all the more interesting. Moreover, the fact of its being so prevalent at Probynabad, points to the possibility of other parts of the province being infected, and by circulating a description of the disease other cases may be brought to light.

Designatio

Designation.—White scour is a disease affecting newly-born calves and foals, characterized by a white diarrhœa of a very fatal nature, and occasionally complicated with lung affection and joint disease.

History.

History.—The disease was first studied by Jensen in 1893 and he, with other workers, considered the cause to be the Bacterium coli.

The real cause of the disease was not demonstrated until Nocard in 1901 was commissioned to investigate white scour in Ireland. He then proved the constant presence of a pasteurella in the tissues of affected animals and reproduced the disease by the means of this organism. (*Bulletin de la Socié'é Centrale de Méd Vét.*, 25th April 1901, page 231.) Lesage and Delmer again found the same organism in calves (*Annales de l'Institut Pasteur*, 25th June 1901, page 231).

Bacteriolog

Bacteriology—The organism is an ovoid bacterium with all the characters of a pasteurella, *i.e.*, it is ovoid in shape about 1·5 micron in length and ·4 micron in width. The extremities are ... clear space in the centre ... ed this is

The two

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s may not

show this clear space, as some will be seen end on when they will appear as ordinary staphylococci.

The organism is very polymorphous, *i.e*, in cultures it may assume bacillary forms or even long thread-like forms.

Characte of the organism

It is non-motile, does not sporulate and does not stain by the method of Gram. It will grow on bouillon and gelatine, but not on potato. It does not liquefy gelatine, and does not coagulate milk. The organism is aerobic and will grow at body temperature. It is a facultative parasite and has a wide distribution, retaining its virulence for a great length of time, unless subjected to extreme heat. The ... not necessary to its existence ...

of its being a Gram negative organism renders its demonstration in the tissues difficult. It may be destroyed by exposure for one hour to temperature of 140°F. It quickly succumbs to ordinary antiseptics such as 1-1000 Perchloride of Mercury, or 5 per cent. Acid Carbolic.

H.

HORSES.	Provisional Report on "White Scour"

Diagnosis.

Diagnosis—Can be assured by the rapidity of the disease, its onset being so soon after birth, and the acuteness of the symptoms. In coli bacillary infection, which causes very similar symptoms, the onset is not usually so early and the disease is more chronic in its action.

The pulmonary complications are also diagnostic and even in ordinary cases of uncomplicated diarrhœa there will always be a slight evidence of bronchial affection. The demonstration of the pasteurella in the fæces is possible, but it is not diagnostic owing to the presence of numerous other organisms.

A certain diagnosis may be made from a *post-mortem* examination providing the examination be made before decomposition has become pronounced.

The acute form will show the inflammation of the gastro-intestinal mucous membrane and congestion of the submucous issue.

The direct microscopical examination of an ordinary smear of the pulp of a mesenteric gland, after staining with methylene blue, will reveal the bipolar organism. It may be found by the same means in the intestinal submucous coat, in the heart blood generally, and in the joint effusion.

To *absolutely demonstrate the true cause the better* way is to inoculate into the muscular tissue of a rabbit, or the peritoneum of a guinea-pig, one cubic centimetre of a dilution in sterile distilled water of the blood, the pulp of the liver, the pulp of a mesenteric gland, or the articular exudate. In order to ensure that other organisms are not present it is better to kill an affected animal a day preceding that on which death would ordinarily take place; but if a recently dead animal is obtainable it usually suffices.

After the guinea-pig's death the organism may be obtained pure in the heart blood. It is more difficult in the rabbit, which is more *resistant and lives longer, allowing other organisms to gain entry.*

Post mortem lesions.

Post-mortem lesions.—The ordinary lesions of hæmorrhagic septicæmia are seen. The whole of the intestinal viscera will be congested. The intestines will show subserous ecchymoses.

The capillaries of the peritoneum, pleura, and pericardium are strongly injected. The colon is intensely congested.

Peyer's patches will be enlarged, salient, and softened. There may be deeply congested ulceration of the mucous membrane.

The mesenteric glands are very enlarged, hæmorrhagic, and gorged with a red serous effusion.

The urine is clear and albuminous. The lungs are congested and œdematous.

In less acute cases the intestinal lesions may not be evident and the lungs may be very slightly affected. The articular structures will be infiltrated and show a jelly-like yellow exudate, and the synovial

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capsule will be distended by a clear yellow fluid, which may be of a rosy colour, with fibrin threads suspended in it. Post-mortem lesions.

The serous coat will show distinctly the congested vessels, and in old cases there will be considerable organisation of the exudate, which latter may have infiltrated the surrounding tissues. The umbilicus will be enlarged and hardened and may be suppurating and becoming brokendown.

The pulmonary lesions will be those of broncho-pneumonia of a diffused catarrhal nature and in some cases there may be grey hepatization and caseous degeneration. Later still the anterior lobes will become hepatized and composed of compact friable tissue, and still later there will be cavities containing a white purulent matter. The bronchial and mediastinal glands will be enlarged and pale in colour. The liver, spleen, and kidneys will be congested only.

Immunisation.—The rapidity in the evolution of the disease and the fact that young animals are infected at the time of birth renders vaccination or the inoculation of a preventive serum or antitoxin very difficult. Favourable Laboratory results have been obtained by producing a toxin from a growth in culture of the pure organism, but its practicable adaptation has had doubtful results. Lesage and Delmer exposed a pure culture of the pasteurella to a temperature of 158° F. for one hour. This kills all the organisms, but their toxins remain; an inoculation of this material is said to produce immunity, but the results are not satisfactory. One attack of the disease from which an animal has recovered will produce an immunity and allow of the inoculation of a dose of virulent culture one-third of which killed an unimmunised animal. Immunisation.

From the disease so-called *Ghotwa* in cattle on which Major Pease has written a report and which is due to a pasteurella, a serum has been manufactured at Mukhtesar which successfully immunises animals in the Laboratory experiments, and it is quite possible that such a serum might be made for the disease white scour. A serum is made by hyperimmunising an animal as an agent for the production of serum.

Treatment.—The disease once established is very difficult to combat and the object in view is to prevent the disease from affecting the lungs and causing the pulmonary complications. If it is confined to the intestines with no complications, there is a possibility of the animal being enabled to shake off the poison. Alcoholic stimulants are indicated in the beginning of the disease, care being taken that none of the fluid should pass into the trachea, and cause irritation of the air passages and so render their infection easier of accomplishment. Acetate of ammonia may be given frequently in Treatment.

Treatment.

very small doses. If the animal shows any improvement tincture of digitalis may be given as an aid to convalescence. If the umbilicus is inflamed or ulcerated it should be washed and asepticised. The animal or animals should be removed from the place in which they are kept and placed in another in as hygenic a condition as possible.

In cases in which the lungs become badly affected, and there is a putrid smell from the nostrils, it is better to destroy them at once as treatment is hopeless and the longer they live the more infection they spread. The object, however, mainly to be aimed at is prevention.

Prophylaxis.

Prophylaxis.—All places in which the disease has existed should be thoroughly disinfected by burning, whitewashing with lime to which Carbolic acid 1 pint to each bucket has been added. All cleaning and stable utensils should be thoroughly boiled for at least one hour. Paddocks which have been used as breeding ones should be ploughed and well limed and used for cultivation for three years before being again put down to grass. Earth floors on which animals have stood should be taken up to at least a foot in depth and disinfected by mixing with lime and carbolic acid or burnt by mixing with dried litter.

Treatment of mares and cows.

Mares and cows which are due to foal or calve should, if possible, be removed to a place in which the disease does not exist and has had no previous existence. In doing this the animals should not be removed at once: it should be done in stages Owing to the resistance of the organism, it will be necessary to move the animals at least three times; at each halting place they should be sponged over with a $2\frac{1}{2}$ per cent. solution of carbolic acid lotion, and the vagina, vulva, and mammary glands, washed with a ·5 per cent. solution of lysol, or chinosol, 5 grains to the pint. The vagina being syringed. Every care at the breeding depôt should be taken to render all appliances, fittings, utensils, and the attendants as cleanly as possible. Especial care should be taken in the cleaning and disinfection of attendants' boots, shoes, or even bare feet, by placing at the entrance to the depôt a tubful of phenyle solution in which they may wash them preparatory to entering the enclosure or space allotted.

The place set apart for foaling or calving should be kept as dry as possible and all litter carefully cleaned and dried daily.

At the time of birth every aseptic precaution should be taken; thoroughly wash the vagina, vulva and mammary glands of the mare with one of the above solutions. The foal or calf should have the mouth sponged with a weak solution immediately on birth. The umbilical cord is also immediately ligatured with an aseptic thread, which thread should be kept in a bottle

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Prophylaxis.

containing a 5 per cent. solution of carbolic acid. The cord is then cut between the ligatures and again thoroughly washed and either a thick dressing of collodion, or an aseptic pad of boric wool applied, and secured in position by an aseptic bandage, which need not be removed for two days unless it becomes displaced, when it should be again applied. This should remain until the wound is thoroughly closed.

Previous to applying the wool and the bandages, a very good dressing to apply to the umbilicus, is the following solution :—

Metallic iodine, 2 parts.
Iodide of potassium, 4 parts.
Distilled water, 1,000 parts.

Or paint the part with the following :—

Metallic iodine, 2 parts.
Methylated spirit, 1,000 parts.

When the spirit has evaporated and the part is dry, collodion may be applied, which obviates the necessity of bandages.

The collodion used is iodised 1 to 100.

I again refer to the difficulty of thoroughly destroying the organism, and wish to point out that none of the above measures will be of any avail unless they are carried out thoroughly in every detail.

The 7th July 1905.

H. 414-436.

G. I. C. P. O.—No. 1710 R. E. P.—12-—C. T.

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(BEING VOL. XII.)

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THE REPORTER ON ECONOMIC PRODUCTS TO THE GOVERNMENT OF INDIA.



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1906.

INDEX

TO THE

AGRICULTURAL LEDGER

FOR THE YEARS

1900—1905.



CALCUTTA
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
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NOTE.

To those who bind the *Agricultural Ledger* two alternatives are suggested; they may bind the issues of each year into an annual volume, or they may keep apart the Series into which it is divided

These Series are as follows :—

I.—VEGETABLE PRODUCT SERIES.
II.—ANIMAL PRODUCT SERIES.
III.—MINERAL AND METALLIC SERIES.
IV.—AGRICULTURAL SERIES.
V.—INDUSTRIAL SERIES
VI.—ENTOMOLOGICAL SERIES.
VII—VETERINARY SERIES
VIII.—FOREST SERIES.
IX—MEDICAL AND CHEMICAL SERIES
X.—IMPLEMENT AND MACHINERY SERIES.
XI.—CROP DISEASE AND PEST SERIES.
XIII—MISCELLANEOUS SERIES.

For either purpose indexes will be published. The annual index will continue to appear year by year; the "serial" indexes will appear at wider intervals.

The annual index refers to the numbering which heads the pages: the numbering at the foot, which is consecutive in each Series, will be used in the serial indexes.

Public libraries and similar institutions are likely to find the plan of binding in annual volumes the more convenient one.

I HENRY BURKILL,
Officiating Reporter on Economic Products to the Government of India.

ERRATA.

No. 2 (1905). Phaseolus lunatus.—Report on the Chemical Examination of the Beans, page 11, line 14 from bottom, for *pe-saulagu* read *pe-santagu*. However, the name *pe-santagu* does not properly belong to Phaseolus lunatus

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Agricultural Ledger, 1905—No. 1			231—240	1—10
"	"	2	241—246	11—16
"	"	4	247—268	17—38
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NOTE.



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G. I. C. P. O.—No. 122 R. E. P.—7-11-1906—2,500—W. J. D.

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The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.